AAPG EXPLORER

OCTOBER 2014

The Last Frontier

Geophysics and geology in Alaska

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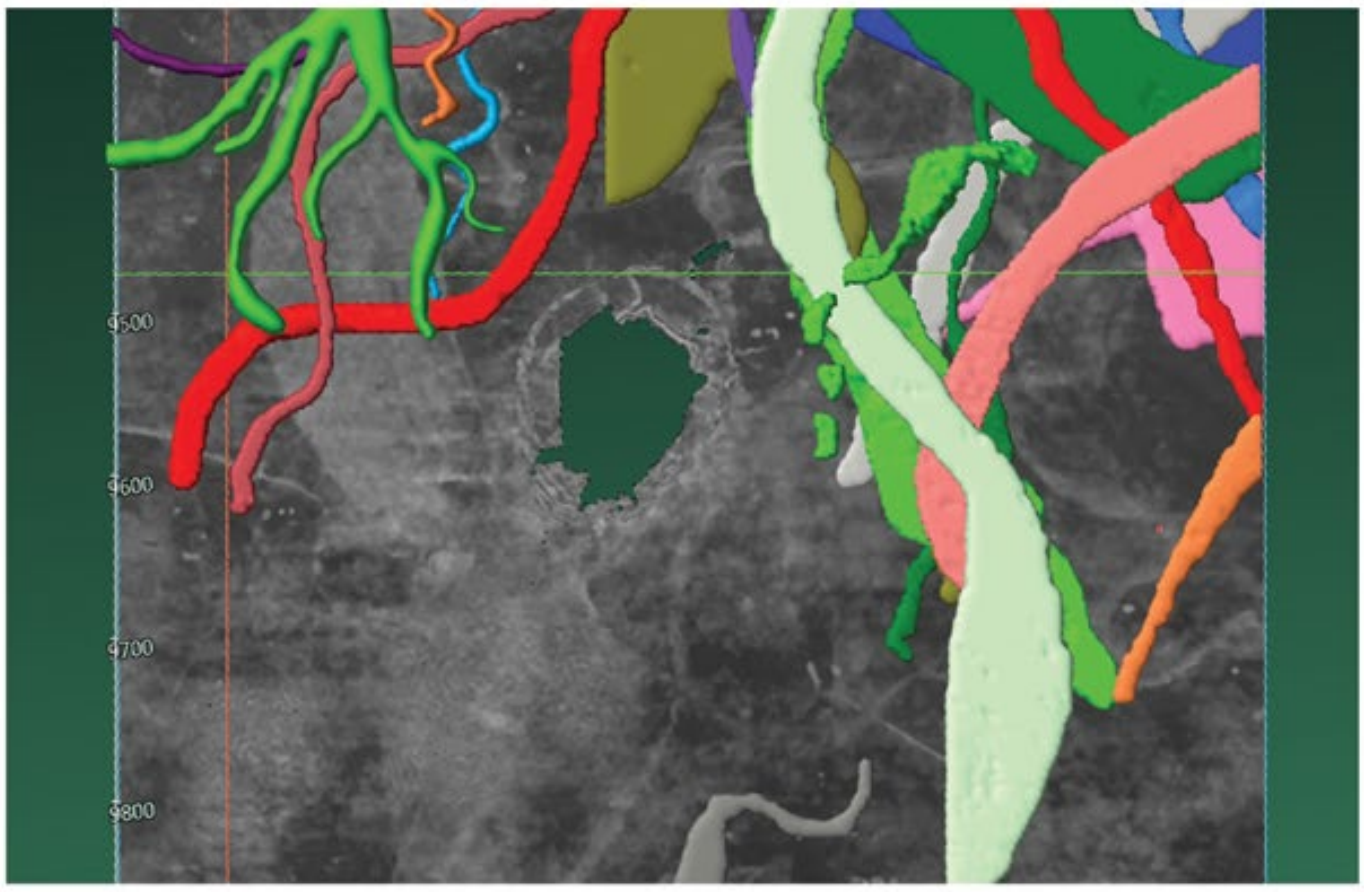

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Vol. 35, No. 10
October 2014

AAPG EXPLORER

PRESIDENT'S COLUMN

Doing what we do better:

Embracing Mitchell's Vision of Sustainability

BY RANDI MARTINSEN

In August, I along with more than 5,000 others attended the second annual Unconventional Resources Technology Conference (URTeC) in Denver. It was a fabulous meeting with numerous presentations that represented integrated geoscience and engineering studies.

One of the main messages speakers conveyed in the opening plenary session, "Using Science and Integrated Technologies to Develop Unconventional Plays," was the need for sustainable development – and that many of the challenges facing continued development of our unconventional resources are above ground.

Indeed, we must address the various issues related to water, to impacts on our environment (such as air pollution, noise and footprint size) and various other concerns of the public.

This same message was conveyed by a number of presenters throughout the meeting, as well as by company representatives who spoke to the media during various press conferences held as part of URTeC.

* * *

Also presented in the opening plenary was a short video on the late George Mitchell – and a longer version was available to watch throughout the conference in the exhibition hall.

Prior to watching this video I was aware of Mitchell's accomplishments and the breadth of his business endeavors, but had not appreciated that he was a visionary who pursued a dream of global sustainability including, but not limited to, delivering sustainable energy to an energy hungry world.

MARTINSEN

Human, environmental sustainability and energy sustainability were at the core of Mitchell's vision and his values.

I knew Mitchell was behind the development of The Woodlands near Houston, but I didn't know The Woodlands was a planned development that represented his vision of a sustainable community in harmony with the environment.

I didn't know he founded the Houston Advanced Research Center, a not-for-profit dedicated to improving human and ecosystem wellbeing through the application of sustainability science and principles of sustainable development.

I didn't know about the Cynthia and George Mitchell Foundation and its focus on sustainability. According to his granddaughter and Cynthia and George Mitchell Foundation president and treasurer Katherine Lorenz, sustainability was a focus for George throughout his life – and one that he instilled in members of his family.

Human, environmental sustainability and energy sustainability were at the core of Mitchell's vision and his values.

I find it ironic that George Mitchell, the "father of hydraulic fracturing technology" (aka, "father of fracing"), a technology that so many people fear or hate because of its perceived negative environmental impact, was so passionate about the environment and sustainability.

This is a message we need to convey.

* * *

I'm gratified to know that the sustainability message is something that's being strongly promoted by our industry as evidenced during the URTeC meeting, but we need to do more to get this information to our families, friends, neighbors, teachers, policy makers and the public at large.

I encourage *you* to watch this video, which soon will be made available by Studio W Productions.

I believe after watching it you will come to appreciate that George Mitchell was much more than a persistent, astute businessman and savvy petroleum explorer and producer whose persistent acumen lead to the unlocking of the shale plays. George Mitchell was a visionary who recognized we must work to ensure society's sustainability, long before sustainability became popular.

The best way to honor Mitchell is to embrace and carry on his vision of sustainable development.

Can you imagine a society that views the petroleum industry as protectors of the environment and champions of sustainable development rather than destroyers?

I can.

Let's work to make it happen.

Candidates Announced for 2015-16

AAPG officer candidates have been announced for the 2015-16 term.

The person voted president-elect will serve in that capacity for one year and will be AAPG president for 2016-17. The terms for vice president-Regions and secretary are two years.

Biographies and individual information for all candidates will be available online in September.

Ballots will be mailed in spring 2015. The slate is:

President-Elect
❒ Paul W. Britt, Texplore Inc., Houston.
❒ Gretchen M. Gillis, Aramco Services Co., Houston.

Vice President-Regions
❒ Adebayo O. Akinpelu, Fixital Ltd., Lagos, Nigeria.
❒ Peter M. Lloyd, Asia Pacific Training Ltd., Falicon, France.

Secretary
❒ Heather L. LaReau, Noble Energy Inc., Denver.
❒ Nicole S. Morris, FireWheel Energy LLC, Fort Worth, Texas.

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REGULAR DEPARTMENTS

Scan this for the mobile version of the current web Explorer.

Photo courtesy of Gil Mull

ON THE COVER:

Looking east along the Weller thrust fault in the central Sadlerochit Mountains in the northeastern Brooks Range, Alaska. Geologists are, from left: Marvin Mangus (ARCO), Howard Sonneman (Humble Oil/Exxon), Don Bebout (Esso Production Research Co.). Photo by Gil Mull, July 1966.

This page: North view to pump station No. 1 in Alaska. See article, page 16.

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Controversy in Colorado

Task Force Appointed in Lieu of Vote

By HEATHER SAUCIER, EXPLORER Correspondent

It was a collective sigh of relief heard 'round the state.

Two months ago, Colorado Gov. John W. Hickenlooper managed to pull off what many call the compromise of the season – the political season, that is, in a state that has been dragged into a months-long, messy battle between the oil and gas industry and politicians and activists who oppose drilling on various levels.

On Aug. 4, Hickenlooper agreed to a deal that kicked two anti-hydraulic fracturing initiatives off the November ballot in exchange for the creation of a task force that would work to find ways for "responsible energy development," as stated by Colorado media.

Had both initiatives remained on the ballot, the public would have been responsible for ultimately deciding the future of the energy industry in the state, which in 2012 realized $30 billion in economic activity and $1.6 billion in public revenue as well as the creation of 111,000 jobs, according to the Colorado Petroleum Association. This would have been the first statewide vote in the country on whether or not to tighten rules on energy development.

"To leave this up to the ballot and for citizens to vote on it – that was promising to be the most contentious fall we would have had in Colorado," said Steve Sonnenberg, past AAPG president, and professor and Charles Boettcher Distinguished Chair in petroleum geology at the Colorado School of Mines.


SONNENBERG

> "It's a huge step forward and I think the people who are coming to the table need to be commended."

He explained that the average person should not have to sift through highly technical information to make decisions that affect millions of dollars in investments and the state's energy security and financial solvency.

"The biggest accomplishment is the governor getting both sides to the table and getting them to be willing to compromise," he said. "It's a big deal. I think everyone is feeling pretty good about it. It's a huge step forward and I think the people who are coming to the table need to be commended for their willingness to assess issues and their undoubted ability to compromise on these issues."

Two chairs and 19 members of the task force were appointed in September representing local governments and environmentalists, civic and business leaders, and industry representatives are currently being selected.

Two are AAPG members: Peter Dea of Cirque Resources and Dan Kelly of Noble Energy – both based in Denver.

"I am looking forward to working with a diverse group of stakeholders to recommend mutually agreeable ways to move forward which respect the rights of mineral owners, citizens and businesses," Dea said. "Fortunately there are many good examples currently in place where local citizens and industry have worked out solutions that protect the environment and respect local concerns while providing many local workers well paying jobs as they responsibly produce the products that all Americans depend on for our quality of life - from transportation, electricity, heating/cooling, medical products, outdoor recreational products, clothing and growing and delivering food."

Looking For Answers

Many are looking to Dea and others on the task force to resolve a host of issues that have been the source of constant contention in the state, said Doug Flanders, director of Policy and External Affairs for Colorado Oil and Gas Association.

Prior to the compromise between Hickenlooper, a former AAPG member, and his major opponent, U.S. Rep. Jared Polis – who backed both ballot initiatives, concerns over setbacks, pollution, traffic, land reclamation, and permitting filled the mountain air and practically every Coloradoan's television screen on a daily basis.

The pulled initiatives aimed to increase setbacks from 500 feet to 2,000 feet, as well as give local communities the majority of control over drilling for the first time in history.

Ironically, industry and local communities have been addressing such concerns for quite some time. Noble recently worked with the Environmental Defense Fund, Anadarko Petroleum Corp. and EnCana Corp. to develop language for some of the most stringent air rules regulating hydrocarbon emissions in the country.

"We want to keep methane in the pipe and out of the air," said Ted Brown, senior vice president of Noble. "It is the right thing to do."

Noble also is systematically

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DJ Basin

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developing its acreage in the DJ Basin to reduce impacts through integrated development plans (IDPs) that cover an area of roughly 100 square miles. Each IDP is developed with a comprehensive design for infrastructure to reduce truck traffic by installing a full network of pipelines to move oil, natural gas and water.

"This long-range planning enables us to sit down with local communities and stakeholders to talk to them about our development plans early in the process. The use of our first IDP in the DJ Basin – incorporating horizontal drilling, pipelines and a central processing facility – makes it possible to reduce the need for tanks on location – saving 626,000 tons of carbon dioxide emissions from trucks, which is equivalent to 66,000 SUVs taken off the road for 10 years," Brown added.

> **"A lot of people will realize the questions they have already have answers."**

Furthermore, Noble and Anadarko created Coloradoans for Responsible Energy Development (CRED) in 2013 to explain in simple terms all that industry has done to "go the extra mile" to address community concerns, especially regarding the heart of the state's energy debate: hydraulic fracturing.

"Fracking (sic) has been safely used over 1.2 million times since 1947," the CRED.org website states. "Today more than 90 percent of oil and gas wells undergo fracking at some point during their lifespan, and neither the Environmental Protection Agency nor the Colorado Oil and Gas Conservation Commission have ever found a connection to chemicals entering our groundwater as a result of the fracking process."

The task force has its job cut out for itself, Flanders said.

"At the end of the day, we have to identify the problem we are trying to address," he said. "What's the question? What's the issue? What's the problem?"

"Once this process gets started," he added, "a lot of people will realize the questions they have already have answers."

Common Ground

In Colorado, a robust engagement process that includes a "local government designee" has been very successful at bridging gaps between industry operations and concerns at the local level, Flanders said.

He added that many on the task force may soon learn that many avenues to compromise are already in place and simply haven't been used because people don't know they exist.

Even after Colorado cities such as Longmont, Fort Collins and Broomfield worked with the industry to successfully develop memorandums of understanding as forms of compromise at the local level, some activists in Longmont and Fort Collins later put bans on the ballot to ban drilling altogether, Flanders said, hinting that concerns about hydraulic fracturing might really be a facade.

"Is this really about regulatory issues that government is able to address," he asked, "or is this really about banning oil and gas?"

In the last month, two Colorado district courts have found in August that local bans on hydraulic fracturing violate state law. In an act of good faith, Hickenlooper chose to withdraw a 2012 state suit against Longmont for banning hydraulic fracturing as part of the compromise.

It is reported that the task force will be able to make recommendations based on a two-thirds majority vote. Setbacks are one of the issues surely to be discussed.

While some might believe that increasing setbacks to 2,000 feet will ease landowners' fears about wells drilled too close to their homes, an increase in setbacks can actually stir up additional controversy, Flanders explained.

A landowner who approves a well on his or her property may find that well is within 2,000 feet of a neighbor's home. If the neighbor doesn't approve the sitting of that well, he or she could prevent the landowner from approving the well.

"It's like your neighbor across the street telling you that you can't park in your own garage," Flanders said. "The further the setback, the more neighbor-to-neighbor conflict you create. The landowner can say 'yes' to the well, the mineral owner can say 'yes,' and the third party with no interest in the well or the mineral rights is telling the two private property owners that they can't access their property."

Such predicaments will be placed in the hands of the task force. However, rather than worry about the nitty-gritty at this point, most are simply breathing more easily that all sides are willing to work to find a compromise.

"We are happy the initiatives are off the table now," Flanders said. "We are not having to argue on the edges. When you make a technical issue political by putting it in the constitution, the argument doesn't go to a compromise. You have to argue in 5-second, 10-second and 20-second sound bites – so now we can have a real conversation.

"We are hoping the members on the task force will approach it in a way of conversation: discussion and understanding rather than fighting and disagreement and angry discourse," he said. "If it's the latter, it will be difficult to find common ground."

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Seismic Industry Suffers Seasonal 'Flu,' With Up-Side

By DAVID BROWN, EXPLORER Correspondent

It might be a well-worn saying, but it fits perfectly in today's industry environment: When the exploration business sneezes, the seismic business gets the flu.

Seismic acquisition companies have financial aches and pains this year because of a reduction in capital expenditures for oil and gas exploration work, especially by international oil companies.

That's produced a series of worried comments from seismic company chief executive officers around the world. The CEOs say their companies are hurting for profit during the current spending slowdown.

But it's not the first slump the seismic business has seen, and this one comes with a number of bright spots.

There's no doubt the biggest players in international seismic acquisition are suffering. CGG in France, a leader in global seismic, reported a significant drop in operating revenues for 2014 year-to-date. That led to a squeeze on its bottom line and a pullback in operations.

"Given the current weak market conditions characterized notably by the unpredictable capex spending of our clients, delays in awarding projects and pressure on prices, we anticipate 2014 to remain difficult," said Jean-Georges Malcor, CGG's CEO in Paris.

"In this context, CGG has decided to accelerate and intensify its restructuring measures into 2014," he said, "downsizing the fleet from 18 to 13 vessels by the end of the year and disposing of its North America land acquisition business."

Photos courtesy of CGG

Given the current weak market conditions, some seismic companies, like CGG, are downsizing their fleets and ceasing land acquisition efforts.

Dutch firm Fugro N.V. reported losses in its geoscience division and took non-cash impairments and write-offs of 346.6 million euros, about $447 million, in the first half of the year.

"We are facing a weakened oil and gas market, related to delays in large capital projects, and hence we have stepped up cost-reduction and performance-improvement initiatives at underperforming parts of our business," said AAPG member Paul van Riel, the company's CEO in Leidschendam, Netherlands.

North American Perspective

North American seismic firms are feeling the pain, too. Dawson Geophysical Co., an industry leader in land seismic acquisition and processing, reported a loss of about $7.5 million in its fiscal third quarter this year.

The company has "experienced a difficult environment during the previous four quarters driven primarily by unanticipated client delays, weather issues and project-readiness issues related to land access permits or agricultural activity," said AAPG member Stephen Jumper, Dawson president, chairman and CEO in Midland, Texas.

Georg Venturatos, an analyst with Johnson Rice & Company LLC in New Orleans, said big exploration companies and other seismic customers seem "likely to remain focused on their recent capital discipline approach."

Venturatos sees signs of a potential demand uptick in the second half of 2014 but said concerns remain, especially over project delays and the seismic order-book mix needed to avoid crew idle time.

"The ocean-bottom cable market remains a bright spot, with a significant backlog of unawarded projects within the market," he said.

Despite the mostly gloom-and-doom talk, not everybody in the seismic business is downbeat right now.

When CGG dealt away its North America land seismic operation, Geokinetics Inc. in Houston acquired it in a deal expected to be final at the end of October.

Company officials are thrilled. Daniel Crowley, Geokinetics president and CEO, called the benefits of the acquisition "compelling."

He said it will move Geokinetics into the No. 1 position in crews working land seismic acquisition in North America, with the company taking the top spot in Canada and second place in both the U.S. Lower 48 and Alaskan markets.

CGG gets a minority stake in Geokinetics and will continue to contribute its patented technology to support the crews, Crowley noted.

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URTeC Was Even Better the Second Time Around; Plans Start for 2015

The second time was even bigger – and many said better – than the first.

The second annual Unconventional Resources Technology Conference, which once again threw a multi-discipline spotlight on new approaches, technology and science being used to develop unconventional plays, attracted more than 5,000 attendees– a 25 percent increase over last year's inaugural event – to Denver's Colorado Convention Center in late August.

More than 230 companies also exhibited at the event, which was sponsored by AAPG, the Society of Petroleum Engineers and the Society of Exploration Geophysicists.

This year's meeting featured 193 oral sessions, 66 e-papers, short courses, field trips, intersociety workshops and a core exhibit featuring rock from 12 North American unconventional plays.

"We are very happy with the attendance this year," said AAPG President Randi Martinsen, "and I see tremendous potential for this meeting as the industry keeps pushing the frontiers on extracting hydrocarbons from unconventional accumulations.

"URTeC is a cutting-edge meeting that is extremely well suited to addressing the needs of the industry as we strive to deliver additional oil and gas reserves to the country, and provide North America with energy security," she said.

Past AAPG president Lee Krystinik, chairman of URTeC's Management Committee, agreed that the conference itself proved to be a valuable resource for those in the industry's unconventionals segment.

"As new concepts and technologies continue to evolve globally, I believe URTeC will remain at the epicenter of technical innovation," he said.

The next URTeC will be held July 20-22 in San Antonio, and the call for abstracts already has been issued.

The 2015 technical program will include 11 themes:

- Regional Case Studies.
- Characterization of Unconventional Reservoirs.
- Application and Integration of Well Data.
- Understanding Your Petroleum System.
- Optimizing Recovery from Unconventional Reservoirs.
- Integrated Approaches and Case Studies.
- Production Performance of Tight Oil and Gas Reservoirs.
- Social Performance (HSSE).
- Reserves Forecasting and Estimation.
- Long-Term Performance.
- Emerging Unconventional Plays.

To submit an abstract, or for more information, go to URTeC.org.

TGS

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Some Signs of Hope

While the international seismic acquisition business is ailing, other parts of the seismic world are less affected by the spending downturn, especially companies with seismic data libraries, reprocessing and imaging services and specialized technologies.

TGS-NOPEC Geophysical Co. managed an increase in net revenues and a small increase in earnings for the first half of 2014. Known in the industry as TGS, the company has financial headquarters in Asker, Norway and operating offices around the world.

"Both sales from the existing data library and customer commitments for new projects were strong and our backlog remains near an all-time high level. TGS continues to be well positioned," said company CEO and AAPG member Robert Hobbs in Houston.

In a hopeful sign for the worldwide oil and gas industry, repercussions from the capital expenditure slowdown haven't slammed other parts of the exploration support chain.

Offshore drillers and rig contractors are getting through the industry down-cycle with decent utilization rates and work backlogs, with weakened demand affecting ultra-deepwater work where a rig surplus has developed.

The big service and supply companies continue to do well.

Halliburton Co. reported record total revenues of $8.1 billion in the second quarter of 2014 and a 23-percent jump in operating income from "significant activity improvements in North America and the Eastern Hemisphere."

"I am very pleased with Halliburton's second quarter results and continue to be very excited about the momentum of our business for the rest of the year and beyond," said Dave Lesar, the company's chairman, president and CEO in Houston.

Schlumberger appeared equally chipper, posting a healthy increase in income from continuing operations. The company saw the strongest growth internationally but also cited an upturn in its North American business, both onshore and offshore.

It might be a well-worn joke, but it fits perfectly in today's industry environment: "How's the elevator business going these days?"

"It's up and down."

The seismic business is like that, too. Right now the market is down, and looking for up.

Silicon Valley meets the oil patch

Marcellus Sees Multi-Measurement Study

By KRISTI EATON, EXPLORER Correspondent

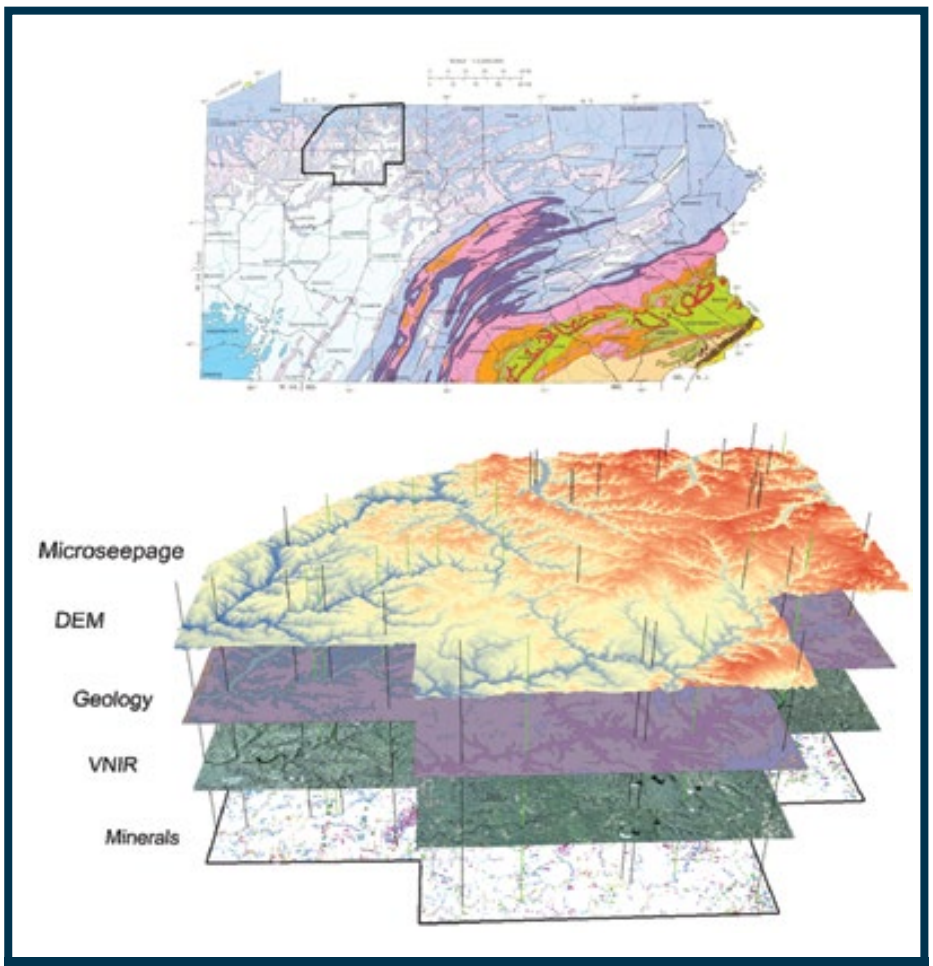
A geoscience company some have billed as "Silicon Valley meets the oil patch" has undertaken a study over the Allegheny National Forest in Pennsylvania.

Airborne geophysical datasets newly acquired by NEOS GeoSolutions were combined with existing seismic, well, and public domain datasets to better understand the potential of the Marcellus resource play in a roughly 2,500 square-mile area of investigation.

Due to the large amounts of natural gas contained within the Marcellus formation, the development of shale has increased rapidly over the last decade; but high spatial variability of both petrophysical and petrochemical properties, along with variations in basement topography and composition, create a challenge in identifying the most prolific, liquids-prone parts of the shale when using only seismic data.

So, in 2013 NEOS GeoSolutions acquired airborne magnetic, electromagnetic, radiometric, gravity and hyperspectral datasets to gain better insight into the region's geology and, especially, the structure and the composition of the basement that underlies the shale.

"We're taking a set of holistic measurements from the basement below the reservoir, up through the reservoir interval itself and then on the surface of the earth, and we combine all of these both qualitatively and quantitatively to provide additional insight to what is going on throughout the geologic column," said Chris Friedemann, chief commercial officer at NEOS GeoSolutions.



Integrated interpretation of the HS Data with DEM, geology. Vertical lines are final identified HC seeps.

From August through October 2013, more than 12,700 line-kilometers of airborne gravity, magnetic, radiometric and passive-source electromagnetic data were acquired.

At the request of one of the program's underwriters, NEOS undertook a series of analyses to map basement topographic and lithologic variations, which were hypothesized to cause localized areas of high BTU production. By integrating and inverting several of the non-seismic datasets, NEOS identified a high-susceptibility region within the basement, which suggested lateral lithological variations within the basement do, in fact, exist.

NEOS also noted a correlation with Marcellus shale production rates and liquids-content, as had been hypothesized.

Operationally, Friedemann said, acquiring airborne multi-physics data can be beneficial because it is obtained using either fixed-wing aircraft or helicopters, which makes data acquisition over a large area fast and cost-effective. Airborne operations also involve fewer people, minimizing HSE risks.

Once the information was acquired,

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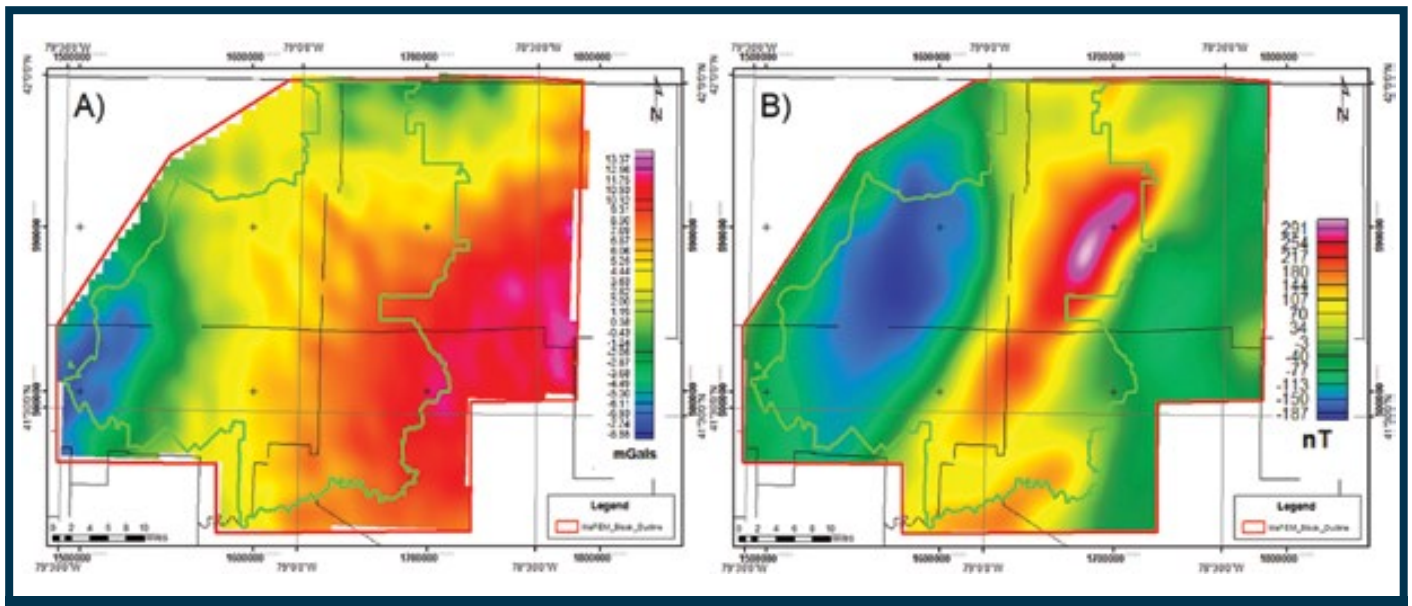

Airborne gravity and magnetic data of the Allegheny Forest portion of the Marcellus shale formation in northwest Pennsylvania.

Data Analysis
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each measurement was interpreted individually to extract subsurface insights including structure, faulting and rock and fluid property variations.

What Comes Next

The next stage is to combine certain measurements qualitatively and quantitatively to derive more insight.

"For example, we might look at the hyperspectral measurements to identify oil seeps on the surface, and then we may go back to the magnetic analyses to see how those seeps got to the surface and whether or not those seeps might have migrated up faults that we mapped using the magnetic data," Friedemann said.

NEOS GeoSolutions also analyzes the data sets for subtle patterns and correlations. Using proprietary algorithms and advanced mathematics and data analytics techniques, they are able to identify the geophysical attributes that correspond with the areas on the subsurface where the higher production, more liquids-prone wells would be found, Friedemann said.

Our predictive methodology involves sorting through these datasets to see first, are there attributes that correlate with the known areas of goodness ... and then pattern searching over a very broad area to see whether or not those same correlative attributes exist in underexplored areas of the play. These insights allow our clients to figure out whether and where you might go next to drill the next wave of wells whose attribute suites match the previous best wells in the play," he said.

The company has used similar approaches for programs in Colorado, Wyoming, southern California and Argentina and is in the process of acquiring data over onshore Lebanon.

Environmental Aspects

The development of the Marcellus shale has increased rapidly because of the large quantities of natural gas in the formation. It hasn't been without controversy, though, especially in this environmentally-sensitive region.

Production within Appalachia has been going on for nearly 100 years, Courtney Ford, marketing manager for NEOS GeoSolutions noted, so there are many abandoned wellbores.

"Some have been properly abandoned, but many have not been as they often were drilled by small operators or private landowners," she said.

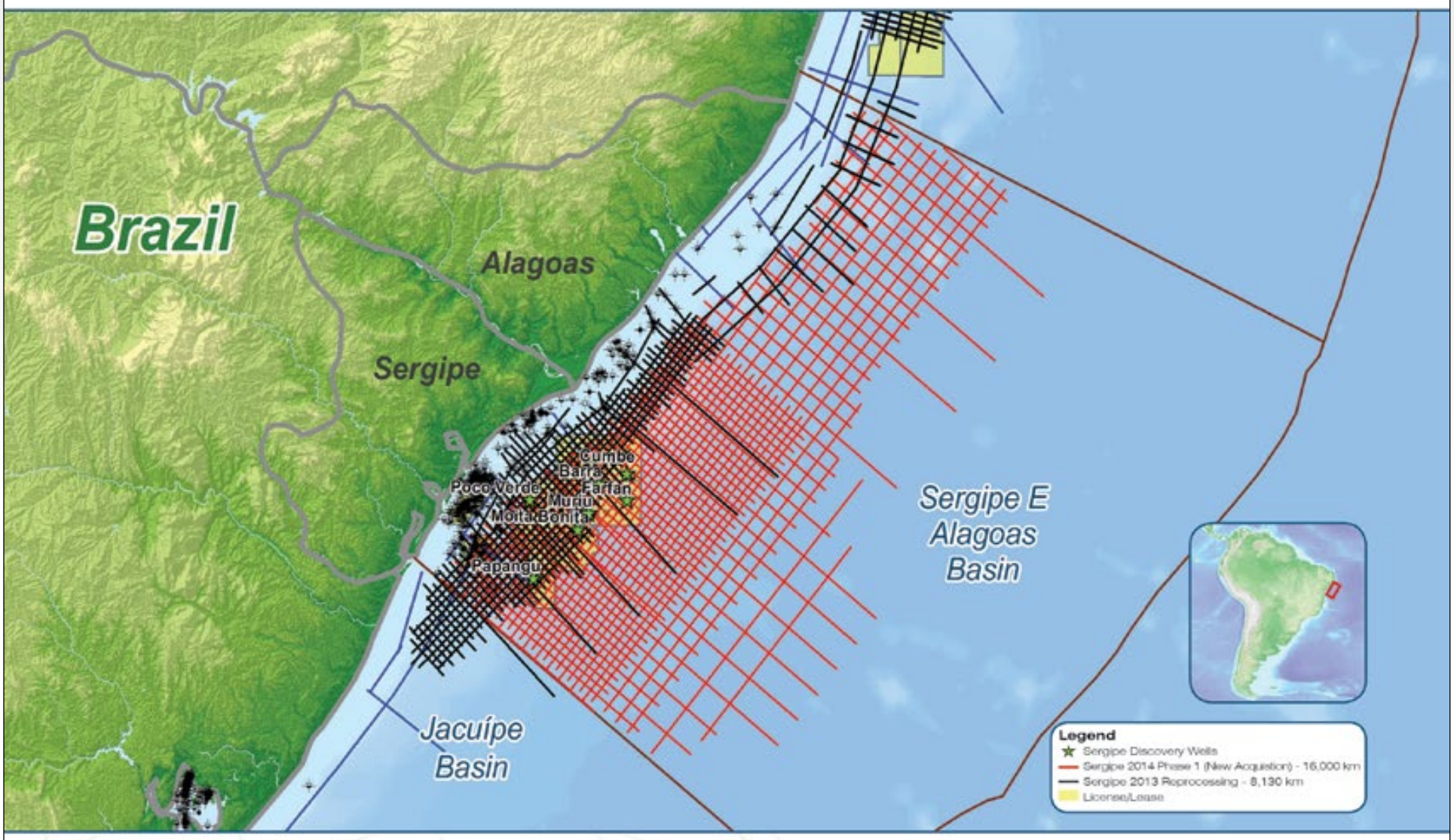
By using the magnetic data, NEOS GeoSolutions can identify potentially orphaned wellbores, as the iron from the casing strings (assuming they are still in place) cause detectable magnetic anomalies.

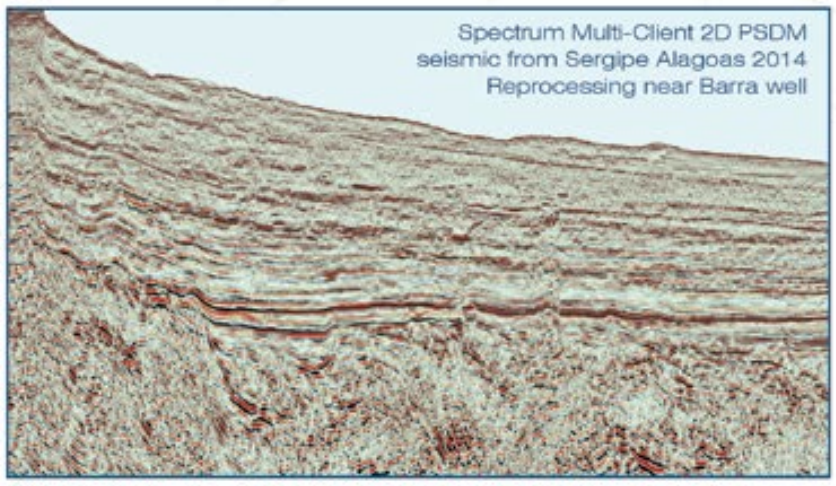
NEOS also can use the hyperspectral data to map oil seeps and methane gas plumes on the surface and, in combination with the orphaned wellbore analysis, determine whether any of the potential orphaned wellbores appear to be leaking.

In addition, NEOS uses the airborne electromagnetic data to identify shallow gas pockets in the subsurface, which might represent a geo-hazard when drilling, as well as natural gas incursions into aquifers, which have commonly occurred throughout Appalachia as hydrocarbons naturally migrated toward the surface over the course of geologic time.

Brazil: Sergipe Alagoas

New 2D Multi-Client Seismic Data Available





Spectrum has commenced a 16,000 km Multi-Client 2D seismic survey offshore Brazil in the Sergipe and Alagoas Basins along the Eastern Margin of Brazil. The new acquisition program will tie key wells in the Basins, including the recent Barra, Muriu, and Farfan discoveries. PreSTM and PreSDM data will be available in Q4 2014.

To supplement the new acquisition in this active exploration area, Spectrum has completed the reprocessing of 8,130 km of data through both PreSTM and PreSDM and is offering this data to industry in order to get a head start on the expected upcoming round in 2015.

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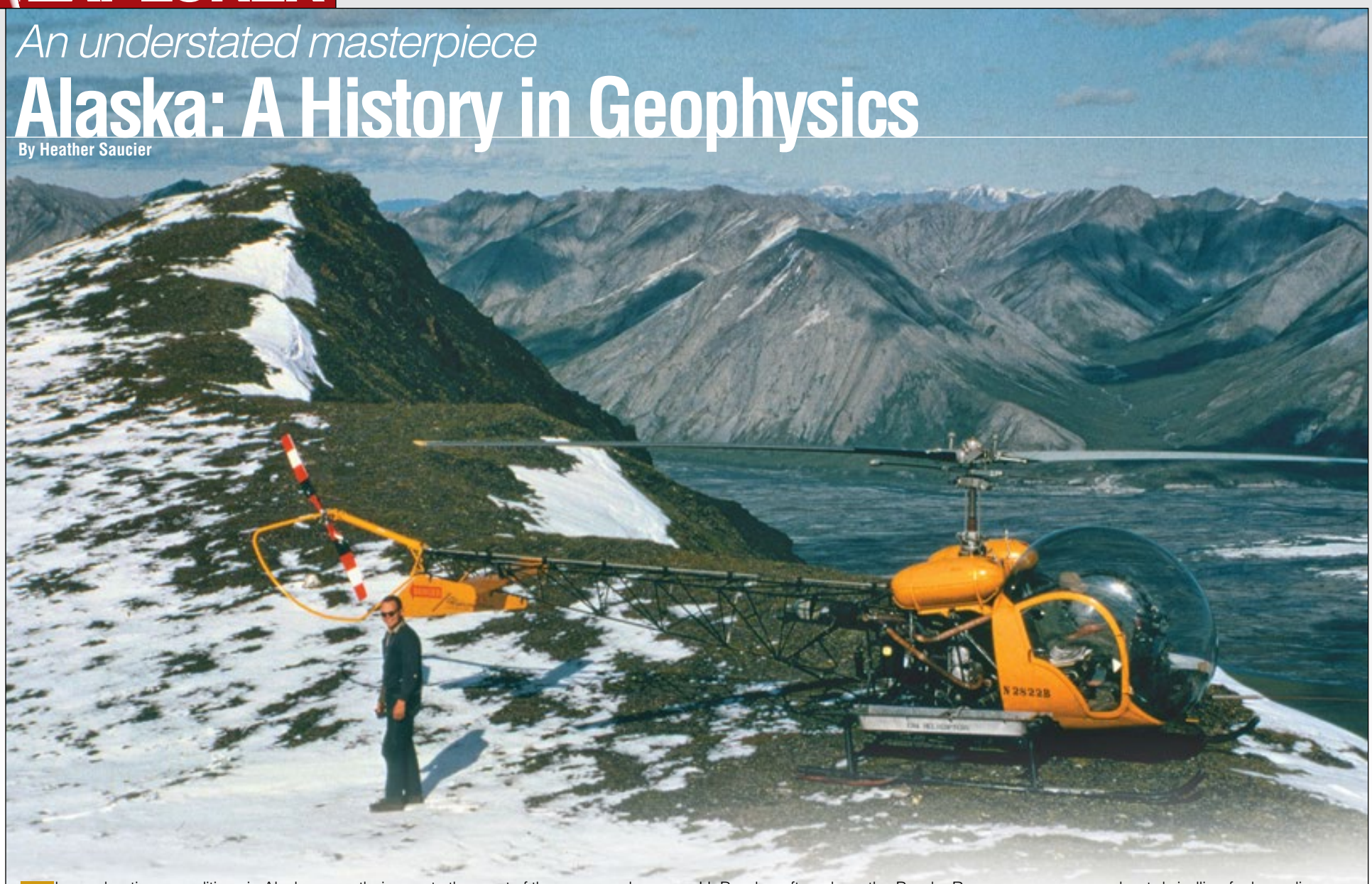
Spectrum

Photo below: Richfield Oil geological field party above the Sagavanirktok River in east-central Brooks Range, July 1963. That's Gil Mull by the helicopter. The Bell Helicopter Model 47G2 was the standard form of field transportation used by all of the industry surface geological field parties mapping in northern Alaska in the early 1960s. Photos by Gar Pessel, who was Mull's field partner and co-party chief of their 1963 field party.

An understated masterpiece

Alaska: A History in Geophysics

By Heather Saucier



The exploration expeditions in Alaska beginning in the late 1800s trump most other places in the world: The nuances of geology and geophysics required to find oil and gas in America's last frontier tell the technical side of the journey, but mix in a history of Native Americans and Russians leading explorers to oil seeps, Hollywood investors, sled dog exploration teams, and rigs disassembled and transported by air for the first time – and science inevitably becomes a bit of lore.

Exploration: An Understated Masterpiece

Oozing from the ground, natural oil seeps marked the beginning of geological and geophysical study in Alaska for purposes of mapping its unknown structures and for finding "black gold" after the Klondike Gold Rush reached its peak in the late 1800s. Oil seeps prompted the formation of the Alaska Petroleum Co. and Alaska Oil Co., which began drilling at Oil Bay and Dry Bay off the Alaska Peninsula near the turn of the 20th century.

Later, U.S. Geological Survey (USGS) exploration teams dispersed across the icy land, sometimes taking four months to arrive at their starting location to record regional topography, the generalized distribution of major rock formations, and fossils, said Gil Mull, an AAPG member and retired employee of the Alaska Division of Geological & Geophysical Surveys and Division of Oil and Gas, after an earlier career with the USGS and the oil industry.

Eventually, their work led them to the more hostile climate of the North Slope of the Brooks Range north of the Arctic Circle. The USGS' first geological transect across the Brooks Range began in 1901.

In the summer, they gathered information on outcrop distributions and rock formations on the mountains. In the winter, they walked behind a team of sled dogs that pulled their gear to the crest of the range and waited until spring for rivers to flow again. They boarded canoes, floated down the Anaktuvuk and Colville rivers, and gathered geological data along the Arctic Coast – a virtually unexplored wilderness, Mull said. USGS geologists F.C. Shrader and W.J. Peters confirmed the presence of coal in a 1904 report.

"These guys were incredible, exploring in an area in which little was known, even of the geography and topography. How did they get to these remote places?" Mull commented. "They spent months in the field in temperatures of 40 and 50 degrees below zero, isolated and living off the land. They titled their report simply, 'A Reconnaissance in Northern Alaska.' I find that a masterpiece of understatement."

The First Maps

Surface mapping produced the first geologic map of Alaska in 1904 by Alfred H. Brooks, after whom the Brooks Range was named.

It confirmed the presence of a sedimentary basin beneath the North Slope. The presence of petroleum was confirmed four years later after USGS geologist Ernest de Koven Leffingwell collected oil from a major seep on the coastal plain near Cape Simpson.

Disappointment loomed despite the discovery, as echoed in the words of Brooks: "Were the region not so inaccessible, it would certainly be worthwhile to investigate these occurrences, but as it is, even if petroleum is found, it could not be brought to market."

Leffingwell continued to explore from 1907 to 1914 on a privately funded expedition in what today is the Arctic National Wildlife Refuge. His final report, which was based on bedrock geologic mapping, attracted the attention of the U.S. Navy.

During World War I, the Navy, which had converted its warships from coal to oil, had concerns about dwindling fuel supplies. Based on Leffingwell's reports of oil seeps, the Naval Petroleum Reserve No. 4 (NPR-4) was established in an area near the central and western North Slope beginning in 1923.

USGS reconnaissance field teams continued to explore NPR-4 in a systematic approach of field mapping.

"Some of these explorations, in an era before the availability of any detailed maps, air support or motorized tundra transportation, were sagas of discovery, adventure and survival," Mull said.

The work led to a broad outline of the geological framework of northwestern Alaska and became the base for a second geologic map of the state produced in 1939 by the USGS.

Photo by Gil Mull

Texaco West Kurupa No. 1, exploratory well in the northern foothills of the Brooks Range, July 1975, which had some good but non-commercial gas shows in the Cretaceous.

Seismic Debuts in Alaska

When World War II commenced, the Navy once again looked to Alaska for fuel, with further assistance from the USGS.

During and immediately after World War II, single-fold seismic data was acquired in Alaska for the first time. Blasts of dynamite sent shock waves into the earth and revealed how the subsurface of rock strata beneath the Arctic coastal plain were folded and faulted, Mull said.

This technology relied on one shot and one receiver with no folding or stacking, said Tom Plawman, an AAPG member and geophysicist with BP in Alaska. In those days, seismic data was recorded on paper.

"There was a time when a computer in the seismic industry was a person," he said. "Processing was done graphically with a pencil and paper. It was a very different world."

All the technical information gathered from field mapping and seismic data during the 1940s and 1950s was published in USGS professional papers, technical

Continued on next page

Photo by Gil Mull

View south along Trans-Alaska Pipeline toward Mt. Sukakpak in Dietrich River valley in the southern Brooks Range.

Photo by Bob Jacobs

Cat train returning to Susie No. 1 for another load of drilling equipment in the move of the drill rig to drill ARCO-Humble Prudhoe Bay State No. 1, February 1967.

Continued from previous page

reports and journal articles – all invaluable to the next wave of explorers: the commercial oil industry.

In the 1950s, areas near Cook Inlet and the Kenai and Alaska peninsulas were explored as well.

An observation made by an air photo interpreter working for Richfield Oil Corp. left the gates for exploration wide open. The interpreter noticed an anomalous oxbow-like bend in the Swanson River in a heavily timbered area on the Kenai Peninsula. It suggested the possibility of a significant structure beneath the surface. In a "gutsy" move, Richfield shot a single, short seismic line running east to west by helicopter, Mull said. It revealed a subsurface anticline that corresponded with the stream anomaly.

So, a well was drilled.

On July 23, 1957, the Anchorage Daily Times printed the first of many newspaper-selling headlines: "Richfield Hits Oil."

The 200-million barrel discovery "really got the attention of everyone," said Mull, who would eventually work for Richfield as a geologist in the 1960s.

"Companies had field parties all over Alaska looking for oil," he said.

Hollywood came to Alaska, too.

In the 1950s, famous Hollywood investors included Walt and Roy Disney, Mae West and Boris Karloff, said Robert B. Blodgett, an AAPG member and consulting paleontologist in Anchorage. In a March 19, 1957 article in the Anchorage Daily Times, it was reported that Karloff flew to the lower Cook Inlet to inspect operations of the Havenstrite Drilling Company, owned by Russell Havenstrite, a multi-millionaire Californian and pioneer Alaska oil explorer.

Head North, Young Man

The Swanson River discovery prompted the U.S. Department of the Interior's Bureau of Land Management to allow acquisition of land on the North Slope for federal and state lease sales beginning in 1958, according to a geophysical case history written by geophysicists R.N. Specht, A.E. Brown, C.H. Selman and J.H. Carlisle (Specht et al) in 1986. During the next three years, seven oil companies made the tumultuous journey north. Some acquired a substantial amount of federal acreage near the Colville River delta and in the foothills of the Brooks Range.

In 1959, after Alaska became a state, it began selecting roughly 100 million acres – including 1.5 million acres on the Arctic Coast – for the sale of leases that could provide revenue for Alaska.

Despite the North Slope's challenging climate, major oil companies committed to long-term exploration there. Reconnaissance surface geological field parties, which were dropped off and picked up by helicopters, operated from tent camps on lakes scattered through the foothills and northern flank of the Brooks Range, according to Specht et al. USGS maps served as the framework for their additional surface and stratigraphic studies.

By the late 1950s, sufficient geological and geophysical data had been gathered to establish a broad outline of the general distribution of the rocks on the North Slope. However, that wasn't enough to strike oil. Companies needed to know if the rocks had structural traps with reservoir potential. In the early days of exploration, the USGS did not gather a substantial amount of information on porosity, permeability and grain size – characteristics needed to help determine reservoir potential. Bringing seismic into the picture allowed the players to map structure and increase the odds of a discovery.

In 1962, BP and Sinclair Oil began the first seismic work performed by industry on the North Slope with a geophysical crew at Umiat. Atlantic Petroleum began seismic operations at the South Ocean Point a year later.

Initially, Richfield was hesitant to perform seismic, Mull said. It was costly, and the North Slope's potential for large accumulations remained in question. However, Harry Jamison, then exploration supervisor for the Pacific Northwest and Alaska for Richfield, made the call when he read a note on yellow tablet paper from field crews insisting that seismic was needed.

"That was one of the advantages of working for a smaller company," Mull said. "Decisions could be made very quickly."

Old Technology, New Finds

Although common depth point (CDP) shooting had just been developed and was being used in other places in the 1960s, the seismic used on the North Slope was the "old-style" single-fold shooting, leaving interpreters to battle with noise interference. During the summer, thawed conditions produced poor geophone coupling and high noise levels from vegetation movement caused by the wind. In addition, "ice breaks," or abrupt fracturing of the permafrost, caused additional noise. The most serious problem was interpreting the permafrost velocity effect that distorts seismic reflections, Plawman said. Before drilling, reflection identification was made strictly by educated guess, he added.

It was soon learned that seismic data was best acquired in the winter. Winter conditions also prevented heavy equipment from tearing up Alaska's tundra, which became soggy in the summers, and damaging the underlying layers of permafrost.

Despite its issues, seismic was the best technology available, and its use was eventually extended north across the coastal plain to the Beaufort Sea.

Lease sales allowed large companies such as BP, in a partnership with Sinclair, to buy significant amounts of acreage. In 1963, BP and Sinclair shot the first line across a location thought to be very obscure at the time: Prudhoe Bay. They completed a seismic grid survey that was 17 miles by 17 miles.

Richfield and Humble Oil (now Exxon) signed a joint exploratory agreement, and by the end of 1964 the companies had acquired sufficient seismic control to delineate two major structures on state acreage: the Colville River delta and Prudhoe Bay. The seismic reflections in both structures roughly correlated with the existing stratigraphic framework, Mull said.

In a 1964 state lease sale, BP and Sinclair acquired a large tract on the Colville structure. In a subsequent sale, Richfield and Humble Oil acquired the majority of leases on the crestal area of the Prudhoe Bay structure, while BP – bidding alone – bought the majority of leases on the flank of the structure, Mull said.

In 1966, BP and Sinclair drilled a deep well near the Colville delta. A dry hole produced much disappointment. In fact, it is rumored that one discouraged manager offered to "drink all the oil that would ever be found on the North Slope," as published in an AAPG paper by W.D. Masterson and J.T Eggert in 1992.

On the Brink of Discovery

About the same time, Richfield – now ARCO after it merged with Atlantic Petroleum in 1966 – and Humble flew in a rig from Fairbanks in a manner unlike ever before. They disassembled the rig, loaded it on a C-130 Hercules cargo plane they leased from the U.S. Air Force, along with the entire drilling camp, drill pipe, casing and supplies, and flew to the North Slope.

The operation required 80 roundtrips.

Mull was one of the well-site geologists for ARCO and Humble's first well, the Susie No. 1, in the Brooks Range foothills about 60 miles south of Prudhoe Bay.

Susie turned out to be a dry hole and was abandoned, and the rig moved by a "cat train" northward to a drill site on the Prudhoe Bay structure.

See **Susie No. 1**, page 20

Geophysical Services Inc. (GSI) seismic shot hole drill rig mounted on a Nodwell tracked vehicle drilling a shot hole for a seismic velocity check shot at Prudhoe Bay State No. 1, March 1968. Photo by Gil Hull

Reifenstuhl presenting a trophy rock award to Alaska Gov. Tony Knowles.

And now a species of his own

A Life Less Ordinary

By HEATHER SAUCIER, EXPLORER Correspondent

Being a good field geologist in Alaska comes with challenges, namely the rough and often unforgiving terrain, not to mention the inclement weather.

When geologist and AAPG member Rocky Reifenstuhl burst onto the scene in Fairbanks in the late 1970s – working for the Alaska Division of Geological & Geophysical Surveys (ADGGS) for 27 years – his passion for extreme sports and adventure naturally spilled over into his profession.

For Reifenstuhl, field geology in the Frontier State became the ultimate hands-on experience.

A native New Yorker named after boxer Rocky Graziano, Reifenstuhl hiked dozens, sometimes hundreds, of miles through moist tussock tundra and other challenging terrain with all his gear on his back, recalled former colleague Gil Mull, an AAPG member who worked for the ADGGS before retiring.

Reifenstuhl was known for always carrying his single-lens reflex camera around his neck to photograph wildlife and rocks. And, after a long day in the field, he often declined a relaxing happy hour with peers to instead cycle up a mountain on a bike with extra wide tires.

It is understandable then, that his family and friends were in utter disbelief over his death in January at the age of 61. Reifenstuhl died in Salt Lake City while, ironically, waiting for a heart transplant.

In the Alaska Geological Society's April newsletter, many recalled Reifenstuhl's insatiable desire to explore off the beaten path. In the field, his exceptional wilderness skills aided significantly in the collection of data he included in his oral presentations and in his numerous maps and reports. They are testimony to the contributions he made to Alaska and the evaluation of its hydrocarbon resources.

"He covered the country like a caribou," Mull said.

Reifenstuhl was honored for his contributions in 2004 when a newly discovered Devonian gastropod species of the subgenus "Palaeozygopleura (Rhenozyga) reifenstuhli" was named after him by AAPG member Robert B. Blodgett, a consulting geologist and paleontologist in Alaska, former colleague of Reifenstuhl.

During his career, Reifenstuhl played a major role in mapping Alaska's Sadlerochit and Shublik Mountains in the northeastern Brooks Range as part of an evaluation of the oil and gas potential of the Arctic National Wildlife Refuge.

He also collaborated with the Alaska Division of Oil & Gas and the U.S. Geological Survey, leading a four-year, multi-agency research program focused on the petroleum geology of the Bristol Bay area.

He was known for publishing maps in a timely fashion, as he was not one who felt compelled to find interpretations for all uncertainties. "He had a saying that 'perfect is the enemy of good,'" Mull recalled.

Rivaling his professional accomplishments were his athletic feats. Reifenstuhl biked to work in the winter – the 50-below temperatures registering as mere balmy conditions for the man who seemed more bionic than human.

He won bike races along the Iditarod trail and often placed in Fairbanks' Equinox Marathon. In his 50s, Reifenstuhl won the Fireweed 400, a 400-mile bike race from Sheep Mountain to Valdez and back.

He and his brother, Steve, once walked a 300-mile segment of the Brooks Range in roughly a week. After he retired, he and his wife, Gail Koepf, also participated in lengthy bike tours in Cuba, Patagonia and New Zealand.

In the geological society's newsletter, a former colleague wrote: "I remember walking toward my tent late one night and there was Rocky, off in the distance, riding his mountain bike atop a low ridge, silhouetted by the midnight sun. I watched him until he was out of sight … That's how I'll always remember Rocky."

Among other distinctions throughout his life, the Devonian gastropod species of the subgenus "Palaeozygopleura (Rhenozyga) reifenstuhli" was named after Reifenstuhl.

Photo by Gil Mull

Prudhoe Bay well heads (Christmas trees) awaiting pipeline hookup, looking south in mid-day twilight at noon in late November, 1972.

Susie No. 1

from page 17

In the winter of 1967-68, ARCO and Humble drilled the Prudhoe Bay State No. 1 well.

Working as one of the well-site geologists, this time for Humble, Mull recalled a spectacular drill stem test that produced a strong flow of natural gas from the thick and prolific reservoir in the Sadlerochit Formation the day after Christmas.

Drilling continued and in the spring showed that the formation contained both oil and gas. A long seven miles away and 400 feet stratigraphically lower than the discovery well, the Sag River State No. 1 well was drilled that same winter by the ARCO and Humble partnership, hitting the jackpot.

It was official: Prudhoe Bay was a world-class oil field.

Newspapers across the country heralded the news on their front pages. "The wildcat well, known as Prudhoe Bay State No. 1, is the first commercial oil discovery on the bleak Arctic Slope, and the announcement spurs hope of the beginning of a new oil boom for Alaska," read an article in the Feb. 16, 1968 Anchorage Daily Times.

Needed for production were equipment for airstrip construction, camp expansion, construction equipment, additional aircraft, fuel supplies, seismic crews, drilling rigs, security measures and a host of other items – all of which were brought in by air or cat train around the clock for days, Mulls recalled.

Production, however, did not begin until 1977 because of Prudhoe Bay's remote location and the need for the TransAlaska Pipeline to be built to transport the oil to Valdez.

Luck vs. Science

While some attributed the discovery to luck, Jamison, who served as Alaska district manager for ARCO at the time of the discovery, had other opinions.

In a speech he prepared in 2008 for a celebration of the 40th anniversary of the Prudhoe Bay discovery, he wrote, "I knew we had been lucky, but I also knew our good luck was based on 10 years of excellent exploration, land acquisition efforts, logistical and operational know-how and management level support all the way to the top … We gave ourselves the opportunity for serendipity through hard, intelligent, persevering work and the guts to back our collective judgment. And it paid off."

The Prudhoe Bay oil field became the largest in North America with an estimated 16 billion barrels of total recoverable oil, overshadowing the East Texas oil field by twice the amount, comprising an estimated 25 percent of the nation's oil reserves.

"The event kicked off the wave of exploration and discovery on the North Slope and adjacent offshore areas that continue today," Mull said. "Prudhoe Bay now has produced more than 13 billion barrels of oil and its 26 trillion cubic feet of natural gas await a pipeline to markets."

Prudhoe Bay was initially discovered using single-fold seismic technology. However, after the discovery, there was an increased incentive to bring better technology to Alaska to help guide

See **Prudhoe Bay**, page 22

Photo by Gar Pessel

Richfield Oil group en-route to visit Richfield's first seismic crew (United Geophysical) on the North Slope, in mid-day twilight, December 15, 1963. Left to right: Harry Jamison (Alaska Exploration Supervisor), Charlie Selman (Alaska District Geophysicist), Pete Gathings (United Geophysical), Gil Mull (geologist), Ben Ryan (Alaska District Geologist).

Prudhoe Bay

from page 20

development of the field, Plawman said.

Additional wells were drilled to help confirm the size of the field as well as shooting more modern 2-D CDP over the field. Geophysical Service Inc. (GSI) shot the first CDP line over Prudhoe Bay in 1969.

Seismic data also helped lead to the discovery of the Kuparuk River oil field on the North Slope in 1969. It became the second largest oil field in North America and produces approximately 230,000 barrels of oil per day with an estimated 2 billion barrels of recoverable oil reserves.

Kuparuk was discovered by Sinclair Oil at the Ugnu No. 1 well, named for the nearby Ugnuravik River.

Photo by Gil Mull

Looking south to Trans-Alaska Pipeline pump station No. 4 and the northern flank of the central Brooks Range, at Mile 271 on Dalton Highway.

Make Way for the Modern

The first 3-D seismic performed on the North Slope was the Gas Cap 3-D Survey at Prudhoe Bay in 1977, Plawman said.

"Initially, 3-D was very expensive technology. It was mainly used to shoot known oil fields in the development drilling process. It wasn't used for exploration because that was too speculative," Plawman said.

"You had to already know you had a money maker."

With time, however, the acquisition and processing of 3-D seismic data improved and became less expensive, making it more feasible to use as an exploratory tool.

"3-D has gone from being a special thing for big companies with major discoveries like Prudhoe Bay to where even relatively small companies can use it today," Plawman said.

Today, using 3-D seismic to explore Alaska's North Slope is a mainstream activity, he added. He suspected companies are looking for another Alpine Field – a good-sized field with a subtle trap, west of Prudhoe Bay and Kuparuk.

Amplitude versus offset, a variation in seismic reflection amplitude, also is widely used for exploration on the North Slope. And, 4-D seismic is now being used in Alaska by some companies to guide development of known oil fields on the North Slope, Plawman said.

Waning Winters

While technology used in exploration may be advancing, weather patterns are becoming more challenging.

"Climate change is a controversial issue, but there is no question that the Arctic is getting warmer," Plawman said. "It's had some interesting impacts on geophysical work."

Namely, the time window for shooting onshore seismic in the winter season is becoming narrower, making it more difficult for companies to mobilize their crews and complete their surveys. Shooting seismic naturally becomes more risky when windows of time shrink in an area where shooting seismic is more expensive, as equipment and people must be transported to remote areas and appropriately weatherized.

On the other hand, the shrinking summer sea ice has made offshore seismic easier to acquire, Plawman said.

On a more positive note, some technology has made shooting seismic during the winter less dangerous. Decades ago, crews performed "hard water surveys" by driving seismic vibrators on the sea ice. This was done to tie onshore seismic data to offshore marine seismic data. As the vibrators moved farther from the coast, the ice became thinner.

Plawman recalled an incident in 1985 when a 2-foot-wide lead on the ice, which was covered in snow, opened up during the night, unbeknownst to the seismic crew. One of the geophone crew members accidentally stepped into the crack and fell in to his waist before catching himself.

"As far as I know, nobody ever died doing those ice shoots, but there were certainly some close calls," he said. "I recall hearing a story that GSI once lost a cat when it broke through the ice. The driver escaped before the cat completely sank, as all the vehicles have an escape hatch in the roof. I don't know of more details about that incident. It's just part of the 'oral tradition' of North Slope exploration."

Setting the Record Straight on Seismic

By EMILY SMITH LLINÁS, EXPLORER Correspondent

"Seismic acquisition causes droughts, earthquakes and livestock deaths."

"Seismic acquisition is not regulated."

"Seismic technology is no longer necessary."

Messages like these cause some industry geoscientists to worry, others to hide from the limelight, others to jump into action.

Colombian geophysicist Jaime Checa has chosen to act.

Checa, the current president of AAPG Affiliated Society Asociación Colombiana de Geólogos y Geofísicos del Petróleo (ACGGP), is dedicating his presidency, and much of his free time, to combatting misinformation related to seismic acquisition in Colombia.

"I feel tremendous frustration and discomfort every time false claims are so widely advertised in the mass media," he said. "False claims have caused significant alarm in communities and even among government officials and regulators."

Checa with community representatives in Colombia's Huila department.

Myth-Busting: Part of the Job

A self-described "quiet and shy" person, Checa is not naturally drawn to public speaking. But his love of geoscience and passion for helping his country motivated him to start speaking out.

"I just couldn't stand seeing the misinformation grow. I started by gathering some technical evidence to destroy the numerous myths about seismic and commenced the difficult task of reaching the public," he said.

Checa developed a presentation called "Seismic Prospecting in Colombia: National Context, Myths and Realities." He delivers the talk regularly to technical and association meetings, community groups and university campuses.

Francisco Trujillo, AAPG Student Chapter leader at the Universidad Nacional de Colombia in Bogotá, said he has attended three of Checa's lectures, which he finds both compelling and necessary.

"[Checa] has been one of fairest and clearest speakers I've seen present the methodology and the impact of seismic exploration our country. He communicates with the general public using language that is thorough but understandable for people with limited expertise in geology," Trujillo said.

Trujillo and former Student Chapter president Miguel Sánchez invited Checa to the University in April to participate in a forum about the crisis in Colombia's Casanare department an area in which severe drought and livestock deaths have been attributed a number of factors, including climate change, agriculture and seismic activity.

Sánchez said he appreciates Checa's use of examples, videos and clear explanations to describe how seismic and other exploratory operations are regulated by Colombia's environmental authorities.

"These lectures do not guarantee a change of opinion overnight, but they help to create an atmosphere of discussion, and they allow people to see another perspective. The good thing is that Jaime doesn't try to sell one particular concept; he presents ideas and facts, and people have the opportunity to debate them and decide in the end which they accept and which they don't," Sánchez said.

According to Víctor Ramírez, president of AAPG's Latin America Region, providing the facts and encouraging discussion are essential for geoscientists in Colombia today.

"We, the geologist and geophysicist community, need to act as 'myth-busters' of the common misconception that seismic acquisition destroys natural habitats and water resources. We also need to educate authorities and communities about the true effects of seismic activities on the environment," he said.

"Most people I talk with find the material very helpful and reassuring. Some still remain skeptical, but I know at least I have been able to let the data speak by itself and to help prevent speculation," Checa added.

His experience working with communities also helps Checa to understand legitimate reasons for opposition to seismic acquisition, including economic factors and occasional substandard professional practices.

"Many regions where oil and gas have been produced for years have not yet seen the benefits of the royalties, which reveals a valid source of discomfort. On the other hand, some sectors have found that blocking the oil operations alleging environmental issues can work as a way to obtain economic benefits of all types," he said.

Another important factor to recognize is the fact that some companies have not upheld industry standards for operations.

"There could be cases in which service companies or operators have not performed according to the best standards. The negative impact that can be caused in these cases is readily magnified and shown as general occurrence," he said.

Community Outreach

The leading cause for opposition to seismic, Checa argued, continues to be misinformation.

"Several wrong messages have been passed to the public through the mass media, talking about catastrophic environmental impacts, even though no serious scientific evidence has been shown to support these claims. As a result, people feel concerned and confused," he said.

Checa proposes solutions for these barriers.

"Obviously, misinformation should be tackled with lots of information, using simple language and reaching all types of audiences. Professional associations and universities play an important role as they are sources of independent information and advice," he said.

Addressing economic concerns can be achieved by separating business negotiations from social outreach efforts and by establishing clear and transparent communication between companies and community representatives.

"The central government and local authorities are key players, providing clear rules and arbitration to solve disputes," he said.

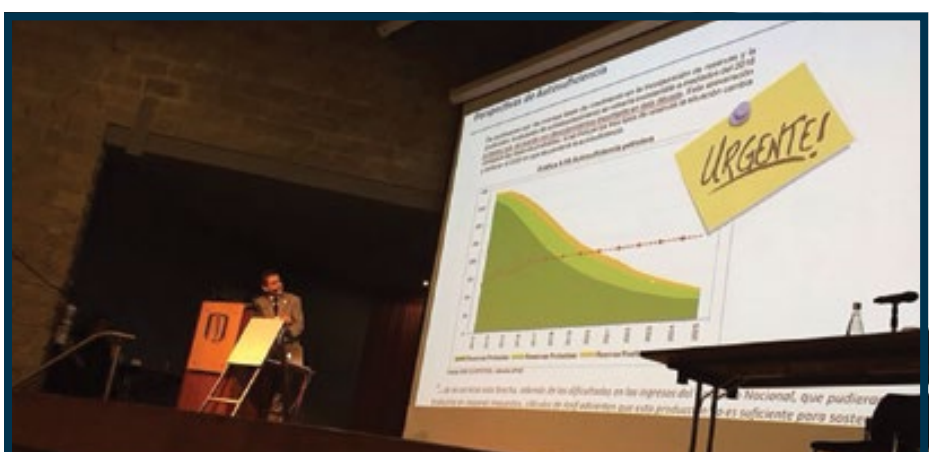
Checa also described the need for consistent enforcement of high standards and best practices, which should be exercised at all times in compliance with applicable regulations.

"Operators and seismic contractors shall work together to improve the planning of operations, which should be based on high quality environmental assessments," he said.

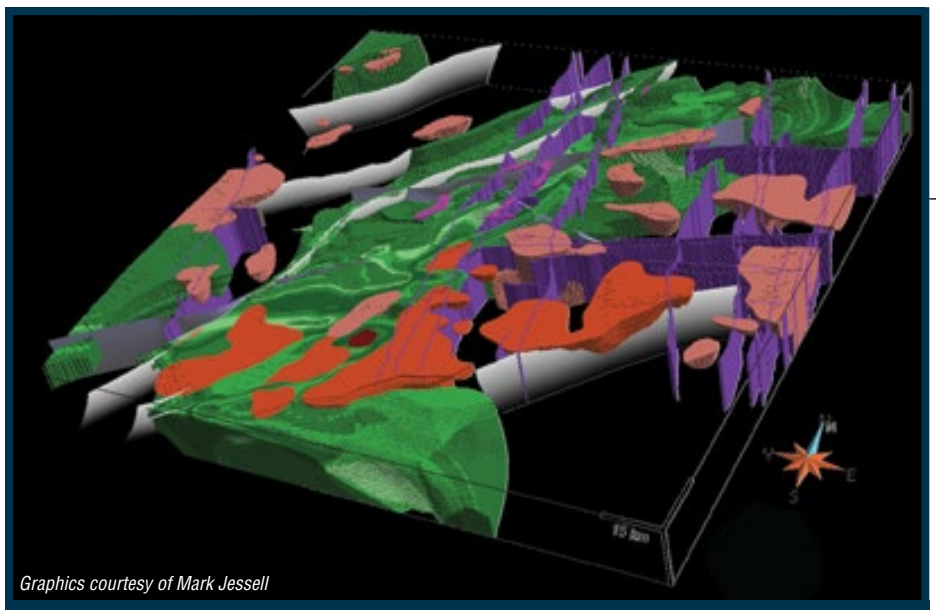
Checa said this three-step approach is essential to successful hydrocarbon exploration, which is a fundamental component of Colombia's economy.

See **Reducing**, page 28

Checa with students from the Universidad Nacional de Colombia in Bogotá following an interdisciplinary forum about the current situation in Colombia's Casanare department. (Pictured, left to right: Francisco Trujillo, Luisa Fernanda Herrera, Adriana Mantilla, Jaime Checa, Miguel Sánchez, Cristian Hilarion.)



Jaime Checa participating in a Petroleum and Mining Forum at Universidad de los Andes in Bogotá.



Graphics courtesy of Mark Jessell

A 3-D geological model of part of the Ashanti Greenstone Belt in Ghana.

Managing Uncertainty With Next-Gen Modeling

By LOUISE S. DURHAM, EXPLORER Correspondent

It wasn't so long ago that geologists and geophysicists each labored in their own separate universe, so to speak, with little or no direct interaction.

In the mid-to-late 1990s, 3-D seismic grew to prominence as a kind of end-all, be-all in the E&P realm, soon creating a synergy between these professions that is considered to be routine today.

It was a significant turning point in the industry.

Geophysical data have proved invaluable to the geologist in myriad ways, particularly as a means to visualize aspects of the subsurface over large areas.

Think 3-D geological models.

"In its basic form, a 3-D model communicates the same information as a geological map," said Mark Jessell, WA Fellow/Winthrop professor at University of Western Australia. "It's a visualization of a geologist's view of the distribution and structural relationships between rock units."

In fact, the model essentially serves as the foundation for further investigation.

JESSELL

A number of different modeling schemes have been developed over the course of the last 30 years to enable geologists to build 3-D geological models, according to Jessell.

They vary in their employment of primary observations and geological knowledge to constrain the 3-D model geometry.

He emphasized that existing 3-D geological modeling systems are well-adapted to environments rich with data, such as basins where 3-D seismic provides stratigraphic constraints. Yet they are poorly adapted to regional geological problems.

"There are three areas where improvements in the workflow need to be made," Jessell said, pointing to:

- Handling of uncertainty.
- The actual model building algorithms.
- Interface with geophysical inversion.

For the novice, geophysical inversion is a mathematical process enabling explorers to obtain added knowledge from geophysical data by converting geophysical measurements into subsurface 3-D images. These images can then be integrated with other geologic information, both subsurface and above ground.

Noting that all 3-D models are under-constrained, Jessell cautioned that the practice of creating just a single model ignores the enormous uncertainties underlying model construction processes. This hinders the relay of meaningful information to the end user about the elementary risk entailed in using the model to solve geological problems.

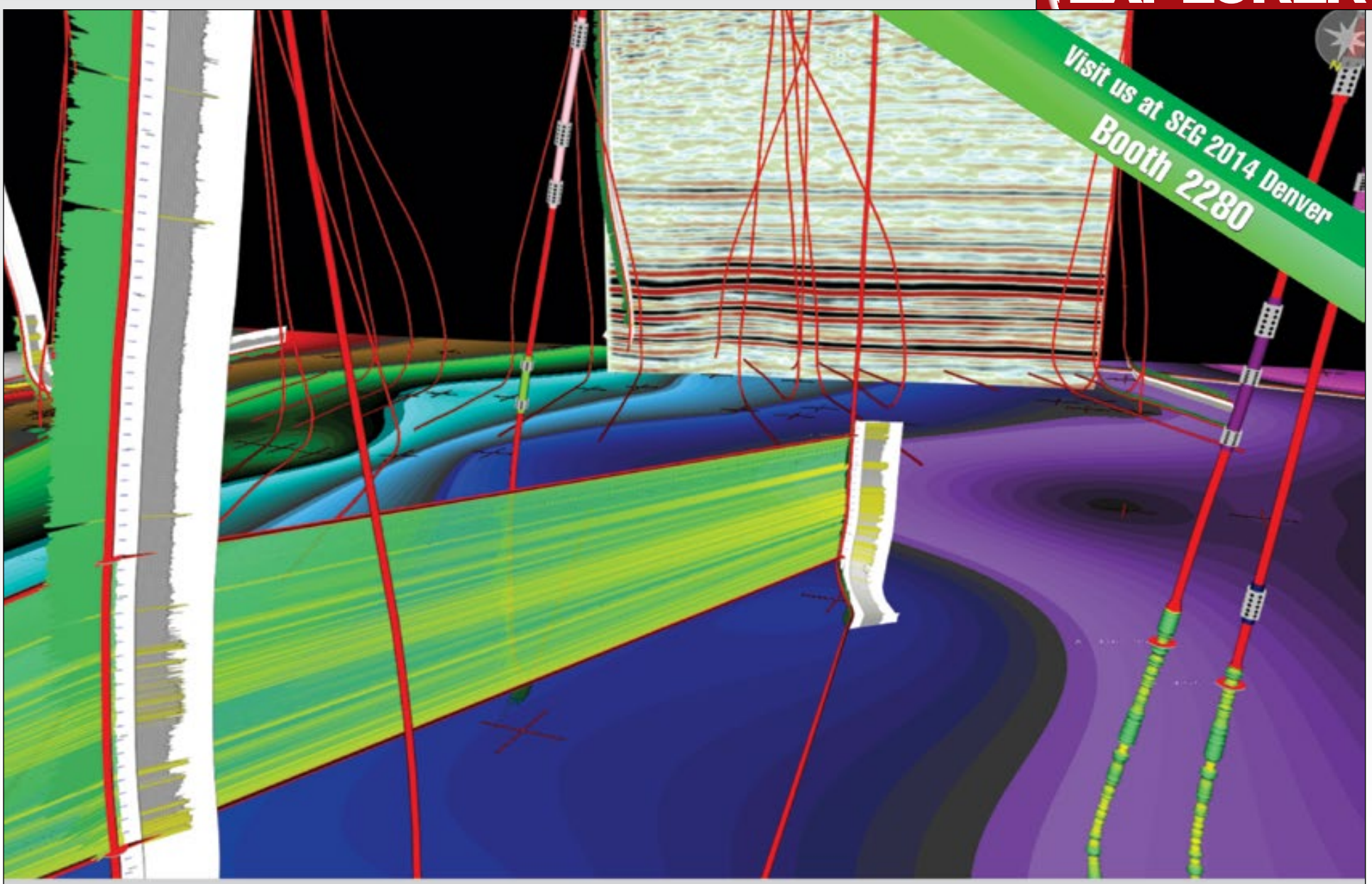
"Future studies need to recognize this and focus on the characterization of model uncertainty, spatially and in terms of geological features," he said, "and produce plausible model suites instead of single models with unknown validity."

Implicit Algorithms

Jessell, who will present the paper "Next Generation 3-D Geological Modeling and Inversion" at the SEG annual meeting at the end of October, noted that the most promising systems for understanding uncertainty use implicit algorithms given that they allow the inclusion of certain geological insight, such as relative ages of faults and onlap-offlap relationships.

However, these existing implicit algorithms lack inclusion of normal

See **Algorithms**, page 28



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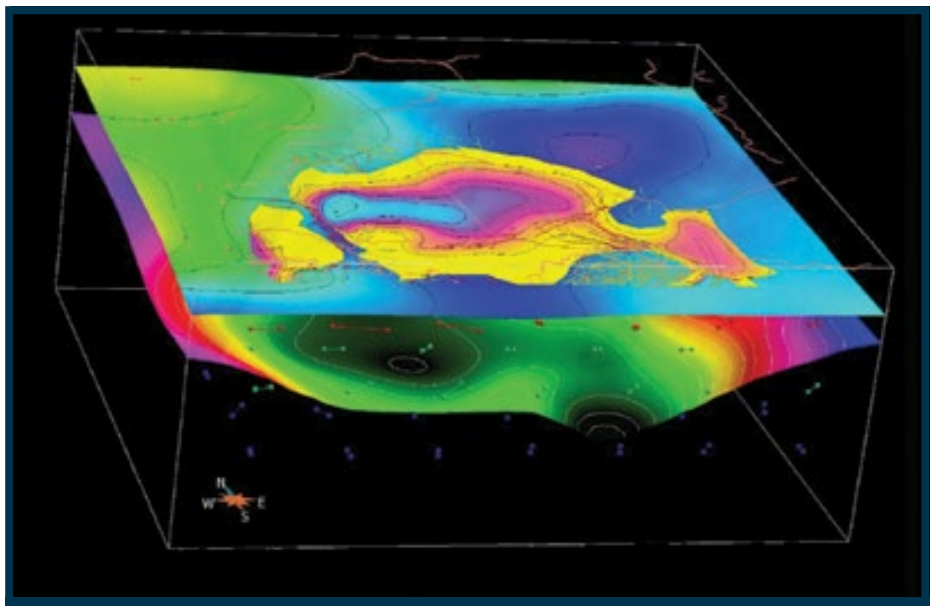


A 3-D geological model of a portion of the West African Craton.

Algorithms
from page 26

structural criteria, such as lineations and poly-deformation recognition, owing to their origin at the mine or basin scale. Such criteria are basic implements for a field geologist who is working to map the geology in a structurally complex area.

As a result, the modeling workflow requires manual intervention.

"One area of future research will be to establish generalized structural geological rules that can be built into the modeling process," he said.

The most formidable challenge, according to Jessell, is the need for geological meaning to be maintained during the model building processes.

Currently, complex 3-D geological models incorporate geological and geophysical data along with the prior experience of the modeler, by means of the interpretation choices.

"These inputs are used to create a geometric model, which is then transformed into a petrophysical model prior to geophysical inversion," he said. "All of the underlying geological rules are then ignored during the geophysical inversion process.

"Examples exist that demonstrate that the increased use of uncertainty characteristics in the workflow can at least partially overcome the loss of geological meaning between geological and geophysical modeling.

"The use of uncertainty metrics provides several potential pathways for the improved integration of geological, petrophysical and geophysical data during inversion," Jessell emphasized.

Reducing
from page 24

A geophysicist at heart, Checa described seismic data as the "most important source of information when searching for new hydrocarbon resources." Reducing the level of seismic acquisition negatively affects prospect generation and exploratory drilling and diminishes production and reserves.

"The oil industry is a big supporter of the country's development, and seismic is what provides the basic information required to start the whole exploration process," he said.

For Ramirez, seismic acquisition should be presented to the communities as an employment opportunity, executed by companies who are fully aware of their social and environmental responsibilities.

He agrees that geoscientists have an important role in explaining how hydrocarbon exploration benefits communities.

"We [geoscientists] need to be the first educators, beginning with our closest circles, avoiding denial and acknowledging that seismic and any exploratory effort has some effect on the environment, but also emphasizing that modern industry is tightly regulated and follows all the rules to respect the environment," Ramirez said.

Checa added that geoscientists – "the individuals who provide the data, knowledge and qualified concepts" – should work closely with professional associations to gather information, integrate other disciplines and maintain the industry's credibility.

Trujillo said Checa has inspired him and other students to contribute to discussions relating to energy development in the world.

"It is our duty to be clear and impartial when communicating information. Our contributions should not only be directed to other geoscientists, but also to members of the general community, who should be able to count on our scientific support when it is time to approve or reject energy projects," Trujillo said.

Trujillo, Ramirez and Checa agree that for this communication to be effective, geoscientists must step out of the classroom and technical meetings and go to where community members live and work.

"We do not have to wait until somebody comes to ask [about seismic]. We need to be proactive and make a visible effort to explain the importance and benefits of our work as well as the environmental impacts involved," Checa said.

"It takes enormous effort and time to convey the right information. It's been harder than I thought, but it's working," he said.

Coiled Tubing For Prospecting Drilling

By LOUISE S. DURHAM, EXPLORER Correspondent

Coiled tubing (CT) has long been used to meet various needs in the oil and gas industry.

In some instances, it is used to actually drill a well.

A far more common application is for well workovers, including drill hole cleanouts and fishing operations to retrieve tools dropped down the wellbore.

The continuous length of pipe is coiled around a take-up reel and is unwound during drilling, then later rewound as the drill string exits the drill hole.

This is in stark contrast to the usual connecting and disconnecting of rigid pipe as drilling occurs.


HILLIS

> "A key positive aspect of coiled tubing drilling is potentially faster and cheaper drilling because connection of drill pipe is not required."

Currently, there are about 2,000 CT drilling rigs worldwide in the oil and gas industry, according to AAPG member Richard Hillis, CEO of the Deep Exploration Technologies Cooperative Research Centre (DET CRE) in Australia.

The organization was established in 2010 under the Australian government's CRE program, which provides funding to build critical mass in research ventures between end users and researchers to deliver significant economic, environmental and social benefits across Australia.

Hillis noted that CT drilling is suited to key niche areas, such as shallow gas wells in Alberta.

Thousands of wells are drilled there annually during continuous drilling programs requiring no mobilization and demobilization.

Given its unique aspects and applications, only 8 percent or so of the existing coiled tubing fleet is involved in drilling.

Hillis and numerous fellow researchers at the DET CRE are working diligently to prove the effectiveness of CT to increase Tier I mineral resource discoveries. These types of discoveries are critical to maintaining the world's inventory of these resources, and the ongoing decline in the grade of those being mined must be reversed.

Because remaining prospective and underexplored areas increasingly tend to be obscured by deep, barren cover, Hillis is promoting a step change in mineral exploration techniques.

"This may be provided by 'prospecting drilling,'" he said, "that is, extensive drilling programs that map mineral systems beneath cover, enabling geophysical and geochemical vectoring toward deposits.

"The technological platform for prospecting drilling must include low-cost drilling due to the dense subsurface sampling required," he noted.

Enter CT drilling technology, with its continuous drill pipe spinning off of the reel in a timely manner.

"A key positive aspect of coiled tubing drilling is potentially faster and cheaper drilling because connection of drill pipe is not required," Hillis said. "This means the drill bit spends more time drilling at the bottom of the hole."

Indeed, even changing the drill bit entails only a speedy round-trip to the surface and back down the borehole.

Even so, there are issues to address.

The DET CRE researchers are evaluating the prime challenges to the use of CT drilling in mineral exploration:

- Its rate of penetration in hard rocks.
- The durability of CT.
- The recovery of cuttings.

The lack of core from CT drilling means that rock characterization must depend on another approach.

Hillis emphasized that the ultimate platform for prospecting drilling would be CT drilling augmented by downhole and top-of-hole sensing.

"The first manifestation of real time downhole sensing is our newly-developed autonomous sonde that is deployed by the driller and logs natural gamma radiation as the drill rods are pulled," he noted.

"Field trials of real-time downhole LWD (logging while drilling) and top-of-hole sensing have demonstrated cost effective, rapid, repeatable and accurate determination of petrophysics, geochemistry and mineralogy, with the necessary depth fidelity, during conventional diamond drilling," he said.

"These techniques can be modified to complement coiled tubing drilling."

Historic Conference Held by Middle East Region

By COURTNEY CHADNEY, EXPLORER Correspondent

Almost like an urban legend, geologists talk of reserves off the Mediterranean coast that contain 850 million barrels of oil and 96 trillion cubic feet of natural gas.

This forbidden jewel lies untouched due to the political deadlock that exists in Lebanon. Evidence in the form of 2-D and 3-D seismic data has reinforced the rumors, but nothing can be confirmed until licenses are granted to drill in the area.

Lebanon's newest natural gas reserve, along with the broad range of other geological attractions in the Middle East region, ranging from conventional to unconventional resources, carbonates to clastics, and structural to stratigraphic provided the AAPG with more than enough reasons to host their first ever conference in the region last May.

The 2014 LIPE and AAPG Northern Arabia Geoscience Conference and Exhibition was held in Beirut, Lebanon last May.

The LPA (Petroleum Administration Lebanon) had held similar successful events in the area, however by joining forces with AAPG's Middle East Region, the two took the next step in enlarging that platform for government and industry delegates, consultants and academic researchers to exchange ideas and knowledge. The convention tackled current trends and challenges in the upstream throughout the northern Arabian region.

Big Turnout

Robert Kuchinski, president-elect for AAPG's Middle East Region Council and member of the 2014 LIPE and AAPG Northern Arabia Geoscience Conference and Exhibition Technical Program Committee, described some of the highlights of the event.

He said feedback included compliments on the conference's strong technical program led by Fadi Nader, "who did an excellent job in attracting very knowledgeable experts that understood the subsurface in the Mediterranean basin."

Kuchinski also noted the large turnout from local Lebanese students, who were not only were present, but enthusiastic and active. Of the hundreds of total attendees from the region, 43 were Lebanese students.

One high point in particular, Kuchinski said, was the opening ceremony address delivered by Lebanese Minister of Energy and Water Arthur Nazarian.

"Whenever you get the head of a government department to officially open the ceremony, it means a lot. If he didn't care or show up, the credibility would have been less, but he came because he felt it was important and his message needed to be heard," said Kuchinski.

Delayed Gratification

The minister's support was especially significant given the recent disappointing news in Lebanon that gas and oil licenses will be delayed until 2015.

This delay came as a consequence of two major political factions, the Sunni-led alliance and the Shiite coalition Hezbollah, not being able to come to an agreement on a presidential candidate.

Kuchinski (left) and Nazarian at the conference in May.

Kuchinski said, "The industry is hoping the auction of licenses process will start again after the country has elected a new president," something they hope will happen in the not too distant future.

The area's complications increase the risk for oil companies wanting to explore there, making it a very challenging region for AAPG's Middle East Region, he explained.

"Nevertheless, we did hold a successful event, but of course not as good as it could have been if the licenses had been awarded," said Kuchinski.

There were still representatives from 20 outside oil companies at the event, from Egypt, the United Kingdom, France, Denmark, Germany, Kuwait, Malaysia, Netherlands, Norway, Qatar, Saudia Arabia, Turkey, the United Arab Emirates and the United States.

It may seem strange to some that AAPG would be hard at work in a place without oil production, but that's only a temporary state of affairs, as Kuchinski and other members are well aware of the potential lying beneath the surface.

"The energy problem in Lebanon and their ever-increasing public debt can disappear if oil and gas production can begin. AAPG would like to play a part in making this happen."Everyone's just waiting. When it happens, it will be a huge market expansion for AAPG's Middle East Region," Kuchinski elaborated.

AAPG decided to host the event for a number of reasons, including the promise of large-scale hydrocarbon development in the Mediterranean basin and the strong ties they had already formed with the LPA.

"We see many opportunities to grow our membership and thus reach out to more geoscientists to offer the high quality of services that the AAPG is known for," said Kuchinski. "The fact that the largest oil companies in the world are either based or operate in our region means there is a real thirst for the most current knowledge relating to technology and geoscience." *(Editor's note: An expanded version of this article is available online.)*

The birth of student expos

Finding Oil in the Minds of Students

By BARRY FRIEDMAN, EXPLORER Correspondent

In the beginning of student expositions – even before the beginning, really – there were two women in an office: a mentor and a student.

And one idea.

"My memory of the beginnings of the student expo in association with the AAPG," said AAPG member Susan Morrice, chairperson of Belize Natural Energy Ltd, "are centered around Marybeth and her desire to make it easier for students, especially those from less well-known schools, to meet and present their best to companies."

The "Marybeth" to whom she referred is Marybeth Hatteberg (then Marybeth Davies), who was at the time a student at the University of Wisconsin, River Falls, looking for a job.

Check that: She was an all-consuming, never-take-no-for-an-answer student looking for a job.

"I believe I met her professor, but perhaps not her," Morrice said of the meeting nearly 20 years ago. "Her professor told her about my work and passion to make a difference in the world."

She liked what she was hearing. It was then that the young graduate student made herself known.

"She began tracking me down to come for an interview," Morrice said. "Marybeth was relentless and sent me all sorts of letters and cards to grab my attention. She wanted that job and pursued me."

MORRICE

> "The student expo job fair is a great way to really see the future."

AAPG's student expos are an opportunity to get résumés in front of potential employers.

Hatteberg, too, remembers it all well.

"My undergraduate geophysics professor (Ian Williams - UW River Falls) strongly encouraged me to connect with Susan. He said there was something very similar about us – an enthusiasm – an excitement for life and exploration. So I made it my hobby to try to get her attention. It took me a long time and a lot of persistence to get Susan's attention. I did a lot of goofy stuff. My office mates thought I was off my rocker."

More Than a Job Prospect

The Hatteberg/Morrice relationship in a sense, then, was similar to the relationships between all those who want a job and all those who have one to offer.

"Maybe," Hatteberg thought at the time, "I should start working for her before she hires me," so she started doing research in Morrice's field area: Belize.

It worked. She was hired.

"I think in her heart," Morrice said, "she wanted to make this process of getting in front of potential employers easier for other students. She saw it as a necessity and that is the mother of invention."

"That's what the student expo is all about," agreed Hatteberg. "Helping the

Continued on next page

Continued from previous page

students get the attention of potential mentors."

And then fate took over.

"I think it was a year or two before Marybeth came to work for me that I had the idea of the international pavilion and had very successfully executed it at the 1994 AAPG Annual Meeting in Denver," said Morrice.

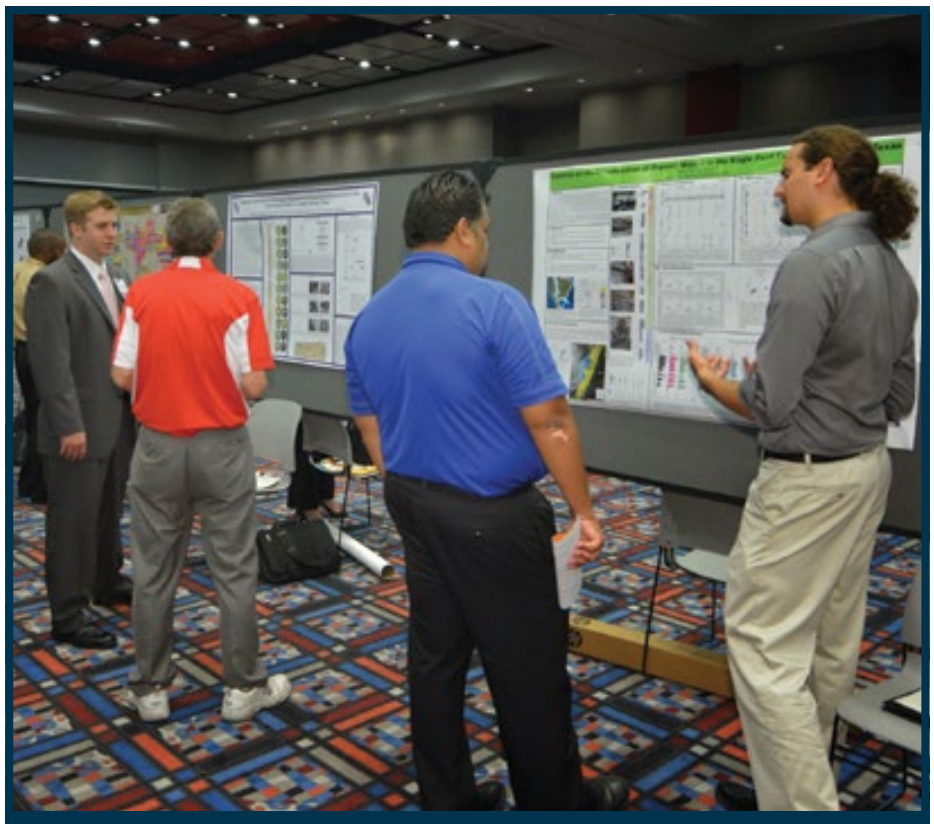
(The International Pavilion, held at the AAPG Convention in Denver in 1994, brought together, for the first time, 52 countries that exhibited their energy potential. For this, Morrice was awarded the Distinguished Service Award by the AAPG as a Global Visionary.)

HATTEBERG

"I was very aware that good ideas needed to be acted upon, otherwise they are useless; and when Marybeth came to me with her idea of the student expo, I was delighted, and encouraged her to focus all of her time into making it happen."

Hatteberg followed her instincts.

"I started the project by contacting geology club presidents and their faculty advisers to see if there was interest. Then I contacted industry folks to see if they were interested, too. It really started as a mentorship program: students finding a mentor to help them get a foot in the door. What I learned from that situation was that once you have someone's attention, you need to show him or her how you could be an asset to their organization. That's what I tried to communicate to all the students who came to that first expo."



Student expos are also a great way to see what tomorrow's geoscientists are learning today.

That first expo was in Denver in 1997; the second, the following year, was held at Rice University in Houston.

"I remember that first year," Hatteberg said, "our office was turned into a viewing gallery for companies to come and meet the students and also see their work firsthand."

And while Hatteberg is somewhat modest about her contribution and her imprimatur on student expos, Morrice will have no part of it.

"She was so much more to all the students. She guided them in how to best present themselves, even what to wear."

"Some," Hatteberg said, laughing, "didn't get the memo about being clean. I did tell them, 'No holes in your jeans.' Students slept on my apartment floor. Others were put up by Susan Morrice, Robbie Gries (past AAPG president) and Deb Sycamore (AAPG member)."

"Her energy and passion for those students was infectious," Morrice said, remembering how her former hire hounded her to find friends at companies to come to the first student expo.

"In essence, although she was young yourself, she was like a 'mother hen' to all of them."

More Than a Job Fair

Looking back, Morrice, who still considers herself an educator, said the idea – a simple one then – still makes inordinate sense.

"The student expo/job fair is a great way to really see the future" and to harness the energy and creativity of the next generation of geologists in what she calls a "balanced, holistic way."

Morrice said it didn't happen by accident and it wouldn't have happened at all without Marybeth Hatteberg.

And here she wants to relay a personal message to her friend.

"Definitely do not underestimate that leadership role you played at the very beginning."

To Morrice, though, when all is said and done, the student expo, even though they now attract almost 700 students and 33 companies, is not just the place to get a job.

"I have continued to explore the mind to understand why some people soar with great ideas and others are reluctant to come forward and are stifled," she said.

"I am a great believer in Wallace Pratt's famous phrase, 'Oil is found in the minds of men.' When our mind is freed up of the clatter of baggage and we can think clearly and creatively, then all sorts of ideas are uncovered and oil is discovered."

Cosmic rays for geotomography

It Came From Outer Space

By KEN MILAM, EXPLORER Correspondent

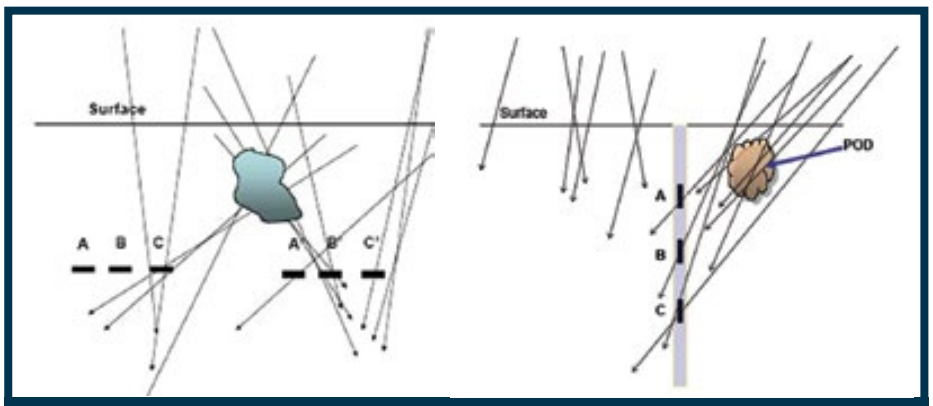
The newest tool in the geophysical kit may have been born a long time ago in a galaxy far, far away.

Researchers at Canada's University of British Columbia are using cosmic ray muon measurements to reveal high-density underground deposits.

Doug Bryman is a professor of physics and astronomy at UBC, where he holds the J.B. Warren Chair. Bryman said muon geotomography uses underground sensors to detect muons as they penetrate the earth.

"The cosmic ray muons are coming from many different angles. They get attenuated as they pass through higher density material – fewer cosmic rays will penetrate," Bryman said. "Underground sensors look up at the earth above and using a series of measurements, we can construct a three-dimensional image. It's very much like CT scanning in the hospital."

High-energy protons originating from distant cosmological sources produce unstable elementary particles, pions, in the upper atmosphere. These particles rapidly decay to muons, which are heavy cousins of the ordinary electron. The high-energy cosmic ray muons can penetrate the atmosphere and, with energies in the trillions of electron volts, some of these muons can reach several kilometers below the surface. Since the intensity of the muons falls exponentially with depth, underground flux measurements can reveal dense deposits.



Principle of Cosmic Ray Muon Tomography: (left) brownfield configuration with sensors A,B,C and A',B', C' located in an existing drift; and (right) greenfield configuration with sensors A,B, and C in a borehole. The flux of muons passing through a high density pod is attenuated.

His interest in the possible exploration applications began about five years ago after colleagues in Japan used the method to study volcanic magma chambers.

"Then a mining person contacted me to see if there was any way to use the technique to locate underground deposits, and I began to work on that," he said.

"It appeared quite suitable for revealing deposits that have a higher density than the surrounding rock," including massive sulfides and uranium deposits, he said.

Bryman said the technique was demonstrated successfully in field tests conducted in an existing mine in British Columbia. Sensors placed in different locations were used to image a volcanic massive sulfide deposit. After that, two more surveys were commissioned by major mining companies at other mines, he said.

"We're developing borehole instruments that essentially can go anywhere. That's a couple of years down the line," he said.

Bryman said the method can help avoid expensive hit-or-miss core drilling.

"In the hospital, if you have a choice between a CT scan or expensive surgery, the choice is clear," he said.

Muon tomography hasn't been applied yet in searching for oil.

Muon tomography sensor.

"In those situations, the density contrast may not be as great, but the potential is still there," he said.

One possible application would be in the area of carbon sequestration, he said.

The UBC group has received support from TRIUMF (Canada's National Laboratory for Particle and Nuclear Physics), its spinoff Advanced Applied Physics Solutions (a Canadian Centre of Excellence for Commercialization of Research) and the Geological Survey of Canada.

Two companies – Near Star, a zinc company, and Tech Resources have been participants in the work since 2011, Bryman said.

"We definitely see commercial applications and we're seeking opportunities," he said.

"It's the only new technique introduced into the tool chest in a long time," he said.

GPS mapping of Latin America

Geologists, Tourists Benefit From Technophile Project

By CHRISTOPHER STONE, EXPLORER Correspondent

Location, location, location.

In the sales world, it's the secret to success.

You can say the same about exploration – except there have been times in Latin America when finding a location *was* the secret.

In one memorable instance, according to consultant David A. Krause, the directions to get to a location in the plains of central Venezuela, the Llanos, included the instructions:

"Turn left at the abandoned white refrigerator after you leave El Sombrero."

Actually, those guidelines worked just fine – until someone took the refrigerator.

"The confusion that ensued was only corrected when someone else was kind enough to abandon another white fridge in the same location," Krause said.

There had to be a better solution – and Krause believes, thanks to the development and growing use of GPS technology, that better solution emerged.

Krause was among those in the late 1990s who got "enthused imagining how the GPS technology could be applied in Latin America in particular" – a region with few road signs to help modern-day explorers.

"GPS devices required highly specialized maps and, although resources were being invested to make GPS maps for rich countries, similar investments in less-affluent regions, such as Latin America, were lacking," Krause said.

"But, as groups of technophiles grew and new mapmaking tools developed," he said, "a way to change this situation began to take shape."


KRAUSE

In the Beginning

In January 2003 Krause started an Internet group (called GPSYV) that served as a forum for people interested in GPS technology and its application in Venezuela. Within months, GPSYV had more than 200 active participants – including people who no longer lived in Venezuela.

"One of the first problems the group set out to solve was matching up the capabilities of the GPS systems with the need for useful GPS navigation aids for Venezuela," Krause said.

Around this time, a Brazilian programmer released an application that allowed users to graphically show and manipulate data that had been collected with GPS receivers. Then an Austrian programmer who enjoyed traveling to emerging countries released an application that enabled the compilation of these maps into a format that could be read by GPS receivers.

In May 2003 GPSYV released its first map.

"It contained little more than a dozen fuel stations and three main highways," Krause said, "but it was the beginning of matching the emerging GPS technology with the needs of users in Venezuela."


A GPS receiver is only as good as the data it can access.

People who traveled around Venezuela began recording the coordinates of destinations and the roads or tracks to reach them, submitting the data to Carlos Solorzano, a Venezuelan programmer who took over the publication of the maps.

"Although these early maps were only 'moving maps' that worked in the relatively basic GPS receivers that were available at the time, both the available software and the GPS receivers continued to improve," Krause said.

Busting Out

In 2006 a Polish programmer released an updated software program that enabled the creation of "routable" or "turn-by-turn" maps that could be used in the GPS receivers that had started to become available, according to Krause.

By this time the data in the Venezuela map amounted to 30,000 locations and 90,000 kilometers of roads and trails.

"The difficulty in initially converting this data into the needs of the routable maps could be compared to trying to tape together 90,000 pieces of spaghetti that were strewn about a room," Krause said, "and the performance of the early version of the maps painfully reflected this."

But the initial difficulties were overcome, and by late 2006 a routable map of Venezuela (dubbed "VenRut") had been produced.

"This was a huge step forward," Krause said, "and as the almost 1,000 members of our group sent additional data and reported items that needed to be corrected, the quality of the maps continued to improve."

(As of last year, the VenRut map includes over 150,000 locations and 200,000 kilometers of roads and trails, according to Krause.)

After VenRut's introduction, further developments progressed steadily.

▸ In 2007, a member of GPSYV who

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Datapages Exploration: Better, Stronger, Faster

By BARRY FRIEDMAN, EXPLORER Correspondent

Let's not bury the lede.

The ability to analyze and evaluate oil and gas exploration just got easier.

A Web-based search-and-retrieval tool can now give subscribers the ability to find hundreds of thousands of geological maps, cross-sections, tables and other "exploration objects" faster and more easily and quicker than ever before.

It's called Database Exploration Objects (DEO), it was designed by AAPG Datapages, and it's up and ready.

It's a system, moreover, that was designed by geologists, for geologists.

But the interesting thing is, much of the technology that makes it work has been around awhile – it was just been waiting for the consumers to catch up.

"The geographical information system (GIS) technology has been around 30 years," said AAPG member Ron Hart, who also is AAPG Datapages manager, "but it took time for technology and data collection costs to come down. Client companies had to adapt their workflow to use the technology, so developers or data base products had no market initially."

Additionally, in the past, only some could access the information. The developers' web browser tools are only a few years old, so client companies had to use special software to take advantage of this new technology.

But now, as Hart says, anyone with a basic web browser can use DEO to find the information desired.

Best of all, it is all ready for quick, easy conversion for use in any explorationists GIS.

Knowing Where to Look

How much information are we talking about?

This is where it gets exciting.

"We have more than half a million exploration objects in our planned conversation," he said of the year 2018.

Specifically, at the moment, there are approximately 35,000 maps in the system.

By mid-2015, he predicts more than 100,000 maps and objects to be available.

But it's not just the amount of data stored – it's also the ease in which it all can be accessed.

Hart used the example of North America's Williston Basin: Presently, a user has to search published articles and other exploration objects, extract that material and then convert it to their current system. With DEO, the process is shortened from days to minutes – and sometimes, to seconds.

This is possible because all the objects in the index can be found one of two ways:

- Matching search terms keyed in by the use.
- The user "drawing" on the interactive DEO maps.

Developing the software, according to Hart, was just one of the challenges in making it all possible.

"We had to work with such a huge accumulation of documents in our conversion," he said, "adding time and cost to the project."

And there were other hurdles, as well.

"Getting the huge database to react at an acceptable level of performance speed was critical," Hart said.

Only because today's servers are faster can they handle the search-and-retrieval of this mass of data in a timely matter. This was not the case even as little as five years ago.

Assets and Advantages

Now there's a new challenge for Hart, AAPG and AAPG Datapages: How to get the word out that this tool is now available.

Hart plans on tackling the marketing of this in a number of ways. Aside from hosting media evenings and attending

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frequently traveled to Colombia suggested a similar project for Venezuela's western neighbor. Users from Venezuela and Colombia pitched in for this new project, dubbed "ColRut."

"By 2009 it was clear that the rapidly-growing attention and dedication required for the project exceeded our available capabilities, so it was transferred to a group coordinated by Carlos Ruiz, a resident of Bogota," Krause said.

- In 2008, Ivo Santamaria, a group member who lived in Venezuela but had married a Peruvian, started to publish GPS maps of Peru – and an Internet group was created to coordinate the work of compiling and publishing the GPS maps of Peru.
- In 2009, William Argueta, a resident of El Salvador, began publishing GPS maps for his country.
- Recognizing the need for a regional program that covered the relatively small and less affluent countries in Central America, in 2010 "SalRut" was expanded to become "CenRut."
- The most recent project has been BoliRut, coordinated by Jesus Hidalgo, which started publishing free maps of Bolivia in 2013.

Variety Package

The variety of uses for which these mapping projects are employed is extensive, according to Krause.

"Countless Venezuelan teenagers regularly list the VenRut GPS maps at the top of their 'must have' applications for their smartphones," Krause said. "First responders consider it an essential tool to reach accident victims or lost hikers (who invariably were not using the VenRut map)."

Other examples, Krause said, include big cat tracking, tourism in the Andes, mountain hiking and to navigate in rural communities that would otherwise require tedious and often dangerous requests for directions.

Today VenRut, ColRut, PeRut, CenRut and BoliRut are cooperative projects that serve to match the needs of travelers in their countries with the capabilities of the GPS technology. The combined memberships of these groups number over 50,000 people, and the freely available maps are currently used by an estimated two million users throughout the region.

And geologists and explorationists all over the region are able to get a better route to the location that could bring big success.

All because someone grabbed that white refrigerator … EE

Datapages
from page 42

conferences, as AAPG did just recently in Amsterdam at the EAGE, he and his team have been using email blasts and emerging technologies to build interest and generate leads.

"We make extensive use of Webex (Webinar) technology to demonstrate real-time speed to prospective clients," he said.

This is paramount, because visitors can – and are encouraged – to request customized presentations and receive free DEO "test drives."

"It must be seen before a purchase decision will be made," Hart said, confidently.

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- It's accessible from any computer, with no new software required.

"By harnessing the power and speed of the latest information technology, DEO puts a whole new world of exploration objects literally at the geologist's fingertips," Hart said.

And, clearly, if less time is spent on search and retrieval that save money, increases productivity and faster identification of opportunities.

"It can make an organization more competitive," said Hart. EE

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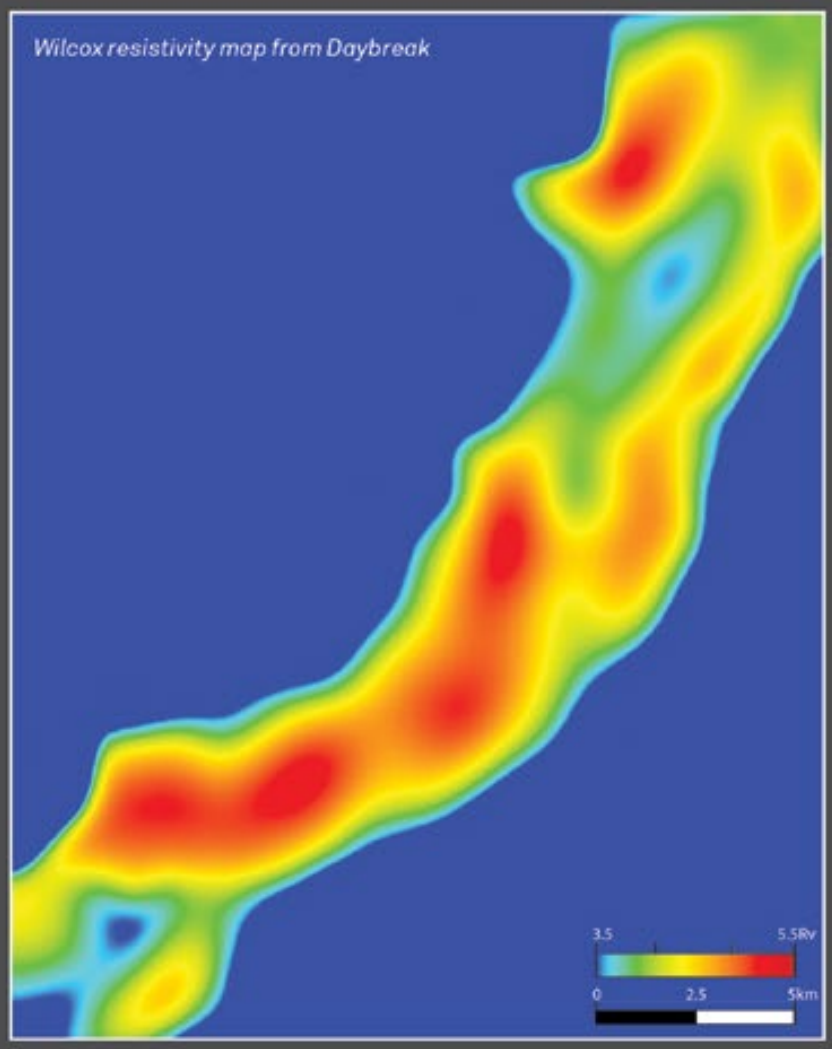

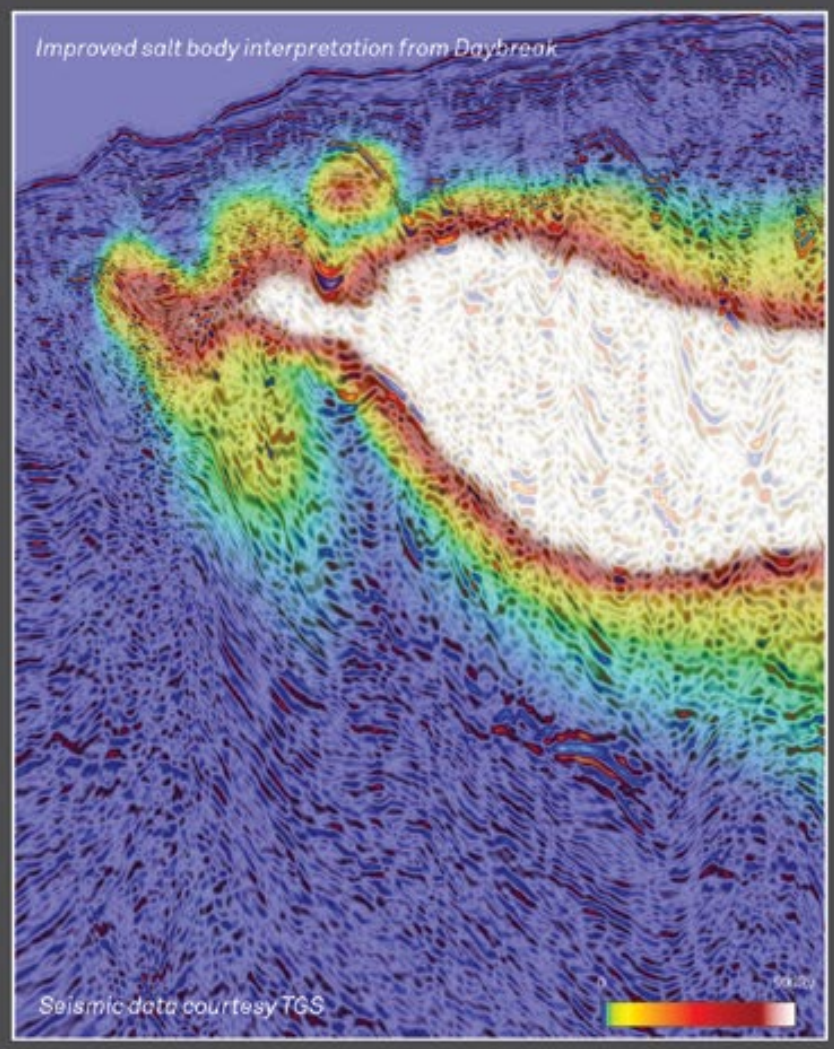

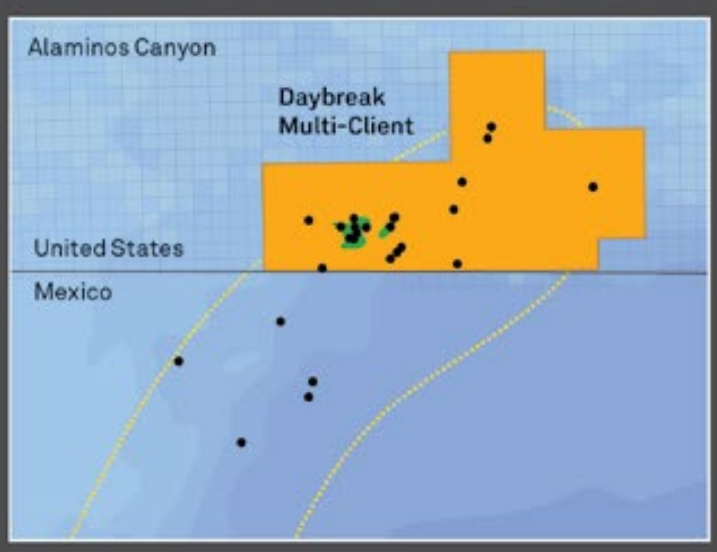

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Toyokawa Field Yields Oil, Prehistoric Asphalt

By EIICHI SASAKI

The Toyokawa field is a small oil field, covering an area of about six square kilometers, located in northeastern Japan's Akita Prefecture.

The hillock area where the Toyokawa oil field is situated formerly was covered with natural asphalt (tar) deposits that had erupted from the subsurface. The current scenery resembles the famous La Brea Tar Pit in Los Angeles.

The tar pit in the Toyokawa oil field – Japan's only tar pit – has an area of 0.5 kilometer by 1 kilometer. I named it the "Toyokawa Tar Pit." Mammal fossils (teeth of Naumann elephants, head bones of boars, horns of deer, and more) have been excavated from the beds in the area.

It is estimated that the asphalt erupted about 20,000 years ago, during the Ice Age, considering the presence of Naumann elephant fossils. The asphalt layers are one meter thick in the Toyokawa hillock area, and five to 10 meters thick where they are intercalated with clay and sand layers in the valley floor and the plain.


SASAKI

Eiichi Sasaki is a petroleum geologist who recently retired from Japan Petroleum Exploration Co. Ltd. (JAPEX), where he worked on exploration projects in Japan, Malaysia and offshore Sakhalin (Russia).

He is devoted to preserving the operational heritage of the Toyokawa oil field and tar pit. He also has studied the ancient history of oil throughout Japan. He is deeply grateful to the late Sabro Iwasa, his Japanese petroleum history precursor.

Figure 1

The Asphalt Jungle

In 1868, Japan shifted from the feudal Tokugawa era to the modern Meiji era. Western types of industries and cultures aggressively flowed into Japan from Europe and the United States.

One of the new technologies was asphalt-paved roads – the first asphalt-paved road was laid in 1879 across the Syohei-bashi Bridge, an iron bridge spanning the Kanda River in Tokyo, using asphalt from the Toyokawa area.

Though this construction was successfully completed, it did not prevail throughout the rest of Japan because it was costly and the asphalt pavement technique was not yet mature.

By 1907, as development of asphalt-paved roads had accelerated in the whole country, the demand for natural asphalt increased, and the mining operation of natural asphalt in the Toyokawa area grew accordingly.

The asphalt mined amounted to more than 4,000 tons in 1912 alone.

As the asphalt was continuously mined, Chugai Asphalt Co., the main miner in the Toyokawa area, had serious concerns that the asphalt soon would be depleted.

The Toyokawa hillock consists mainly of shale of Neogene Tertiary age. Chugai Asphalt confidently believed that oil would be present in the subsurface formations.

On Feb. 24, 1912, Chugai Asphalt drilled the first well where they thought was the axis of an anticline, as was reported by the newspaper at that time, using a U.S.-made cable tool drilling rig. However, it seems that the drilling location actually was on the eastward-dipping flank, based on the geological map and the geological section published in 1903 (figure 2).

This well reached a depth of 390 meters on Feb. 26, 1913, finding several oil-bearing layers. These layers were tested and produced from 31 to 120 barrels per day. However, since the borehole collapsed because of the pressurized shale layers and the squeezed oil sand, it proved very difficult to control the conditions of this well.

These oil-bearing layers were named the "Toyokawa Oil Reservoir," and the newspaper reported that this type of reservoir had never been found or recorded in the past in Japan.

The drilling was stopped at the depth of 442 meters, and the operation was completed on Oct. 28, 1913. It had taken one year and eight months to complete the well.

How to Succeed In Business

Several more wells were drilled concurrently with the No.1 well, and these resulted in rather poor production of oil – less than 6.3 barrels per well per day.

Chugai Asphalt even changed its name to Chugai Oil Asphalt Co., though the company was commercially unsuccessful.

Then, to carry out more aggressive activities, the company increased its capital with the investment made by the Okura family (one of the zaibatsu families, which controlled various sectors of the Japanese economy) and other interested parties. In 1914 the company purchased an American-made rotary drilling rig and invited an American drilling engineer to the Toyokawa oil field.

One year later, a Mr. Youngring, who had drilling experience and a bachelor's degree in petroleum engineering, was employed by Chugai Oil Asphalt. Unfortunately, the results of the drilling were disappointing and the production of oil was very poor; Youngring left the field one year later.

As the company needed further financing, it decided to transfer to another company, Ogura Oil Co., a part of the concession area where they thought the potential of oil was low.

In 1915, Ogura Oil drilled its first well, and at the depth of 486 meters it

See **Ogura**, page 48

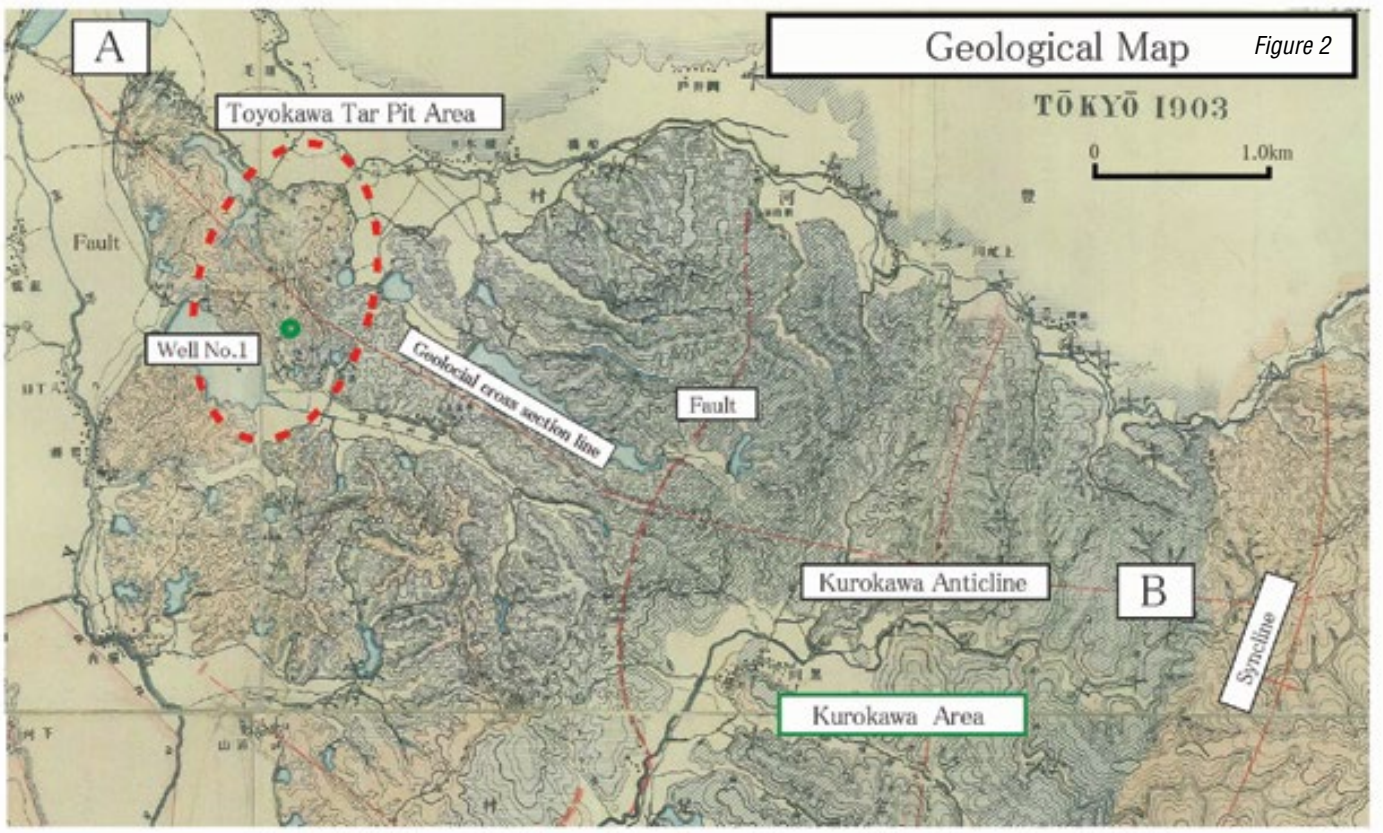
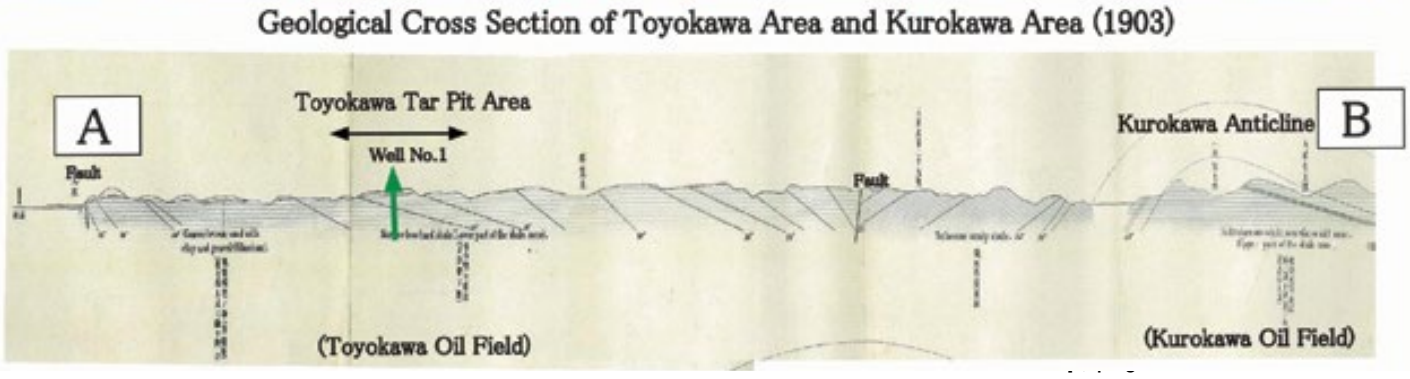


Figure 2

Geological Cross Section of Toyokawa Area and Kurokawa Area (1903)



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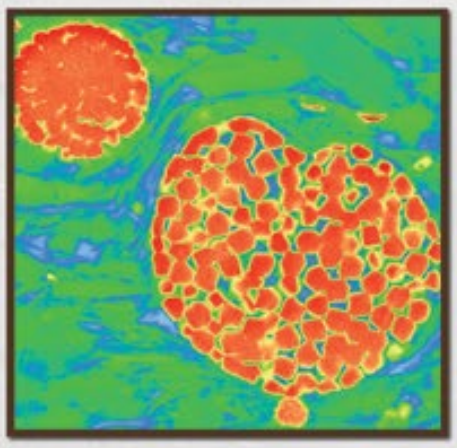

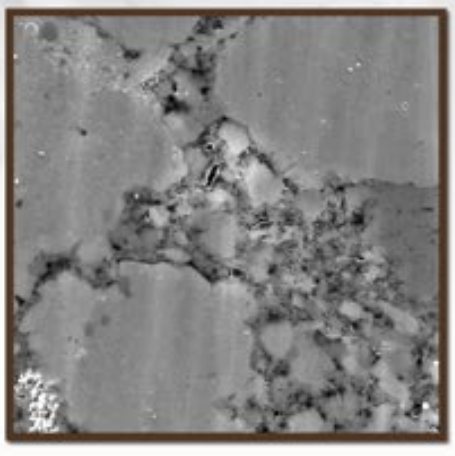

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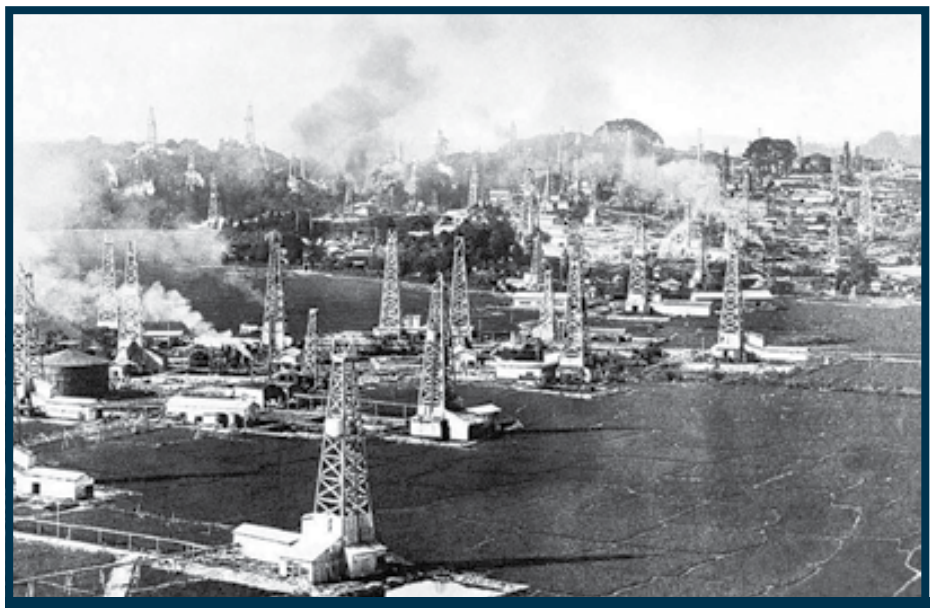

Figure 4 – The scenery of Toyokawa oil field (1919).

Ogura
from page 46

hit a spot that produced more than 906 barrels of oil for a time, and later flowed an average of 113 barrels per day.

Hearing of this success, Mr. Takakuwa, who was then responsible for technical engineering at Chugai Oil Asphalt, decided to change the well locations. The Toyokawa rotary No.12 well was drilled on the 10-degree southeast of the anticline plane (down-dip of the east side of the anticline).

In November 1915, the Toyokawa rotary No.12 well reached the depth of 430 meters, which successfully resulted in an oil production of more than 453 barrels per day.

Chugai Oil Asphalt maintained the same policy for the subsequent drilling locations. After those activities continued, the financial basis of the company became stable.

Gone With the Wind

A subsurface structure map of the Toyokawa oil field in the early stage (1919) is shown in figure 3. The contour (red) lines indicate the top of the lower oil-bearing bed (Toyokawa oil reservoir).

It was believed that the structure of the Toyokawa oil field is divided into three blocks by east-west faults, and this contour map indicates almost an east-west trend. However, the trend of the successful wells seems to be aligned with the north-south trend line of the Ogura well No.1 and the Toyokawa well No.12.

Figure 4 depicts the scenery of the northern part of the Toyokawa oil field when the structure was being delineated.

Both figures also indicate that the well locations were evenly spaced at intervals of about 200 to 300 feet to avoid interference. Oil exploration and development technology was fully introduced from the United States by not only importing the drilling equipment, but also American operating know-how into Japan.

To the east of the Toyokawa oil field is the Kurokawa oil field, which is a typical anticlinal structure with four-way closures (figure 2). On May 26, 1914, the Kurokawa No. 5 well, operated by Nippon Oil Co., became a gusher flowing more than 12,000 barrels per day.

The news of this enormous success quickly ran throughout Japan as the culmination in the history of oil development in Japan.

The operation in the Toyokawa oil field was taken over by Nippon Oil from Chugai Oil Asphalt. In 1921 the annual production of the field reached the maximum of 547,000 barrels; after that oil production gradually decreased.

The production depths in the field were in the range of 300 to 450 meters. The ability of many production wells suddenly decreased as well. For an effective operation and increased oil production from the wells, pumping units were imported from United States starting in 1921.

Drilling in the Toyokawa oil field was finished by 1940. After that, only the production maintenance operations continued.

Trading Places

The total number of wells drilled at this field is 716. This number seems to be quite large compared with other oil fields of similar size.

This is largely because of the characteristics of this oil field. The reservoir zones consist mainly of broken breccia of hard shale and of mudstone containing less sandstone and tuff layers. This indicates that the reservoir is a fractured type.

The largest production came from the wells drilled in the lower part of the structure. The oil is asphaltic base and 13.4 to 18.7 API. The drive-mechanism of these reservoirs in the field seems to be an irregular edge-water system without a gas cap, which it is why it was necessary to drill so many wells to recover the production volumes.

Figure 5 indicates the geological cross section between the Toyokawa oil field and the Kurokawa oil field as reported by

See **Kurokawa**, page 50

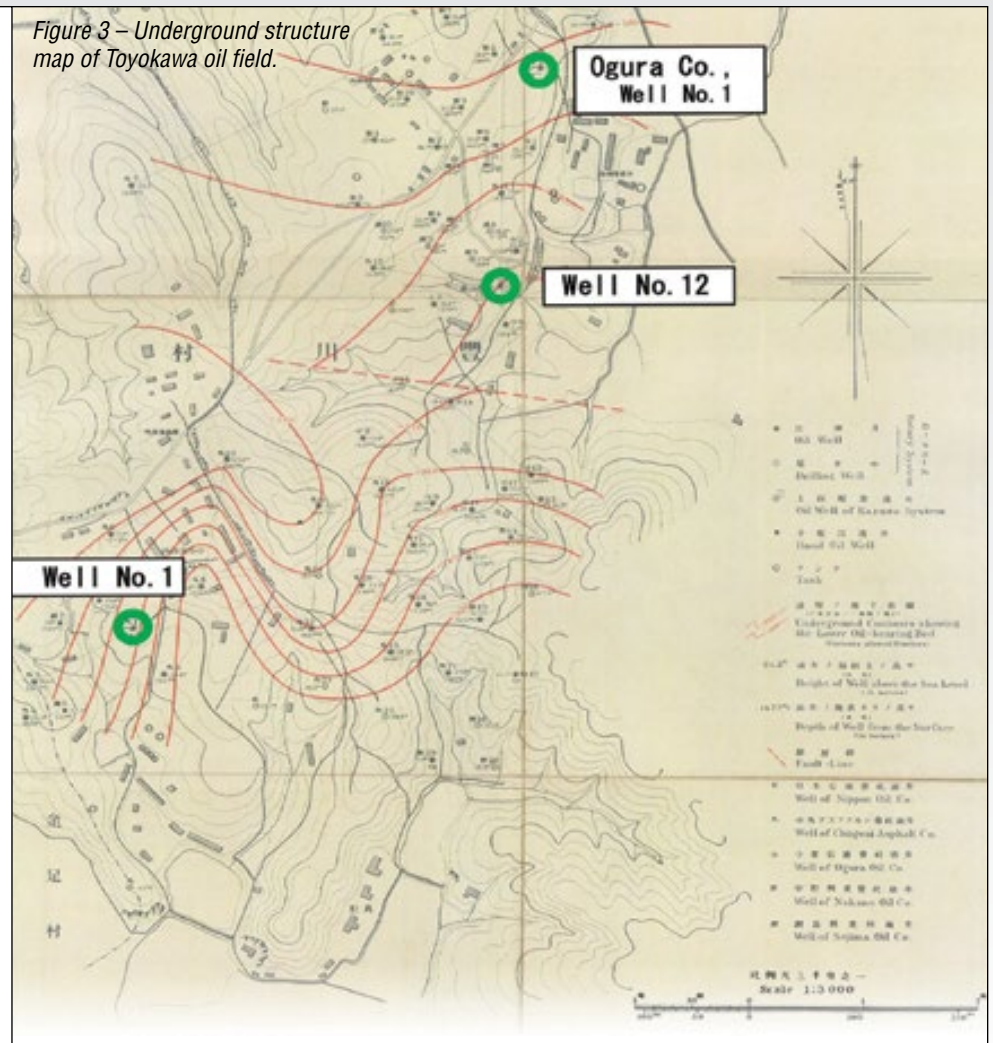

Figure 3 – Underground structure map of Toyokawa oil field.

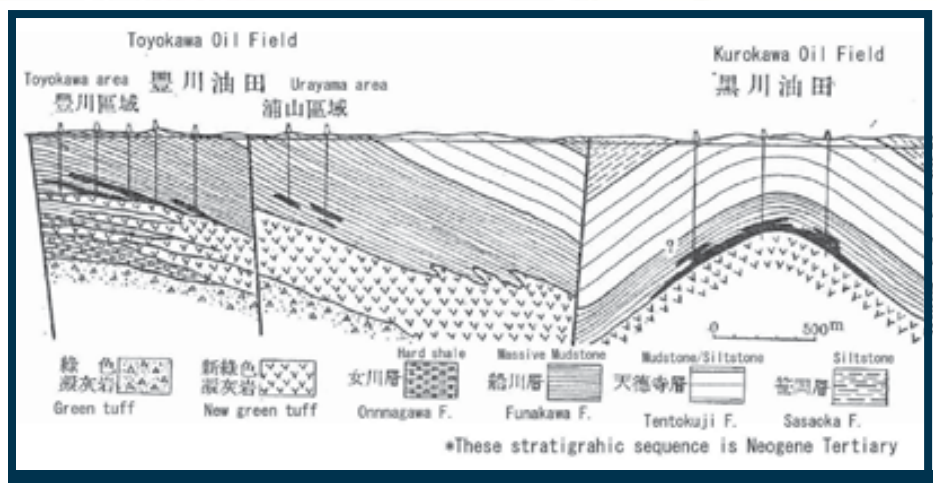

Figure 5 – Geological cross-section between Toyokawa oil field and Kurokawa oil field (1934).

Kurokawa

from page 48

Ichizo Omura (1934).

Oil production operations at Toyokawa field, the first fractured-type reservoir discovered in Japan, were terminated in 2001, with a cumulative oil production of about eight million barrels.

At present, a small amount of natural gas is produced from this field, now more than 100 years old.

An interesting side note: modern Meiji-era Japanese were not the first users of Toyokawa asphalt.

In pre-historic times, about 5,000 years ago, the Jomon people lived around the Toyokawa area; for them asphalt was a very important material. They used it as an adhesive for broken earthenware and as a strengthener at the joint part of arrowheads or knives made of stone and obsidian, as seen below in Figure 6.

Archeological surveys also indicate that Toyokawa asphalt was used in areas a few hundred kilometers beyond the Toyokawa Tar Pit in Akita, perhaps taken there by trade.

The Jomon people must thus rank among humanity's earliest documented users – and presumably, traders – of oilfield products.

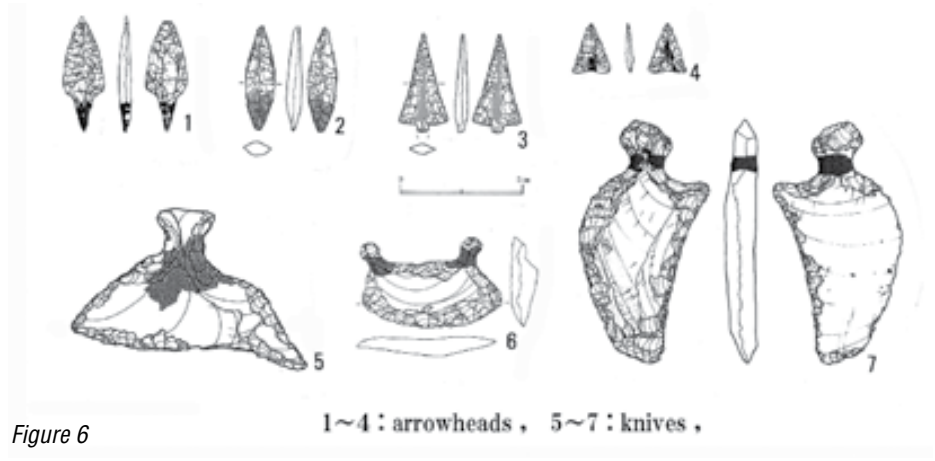

Figure 6

The Geophysical Corner is a regular column in the EXPLORER, edited by Satinder Chopra, chief geophysicist for Arcis Seismic Solutions, Calgary, Canada, and a past AAPG-SEG Joint Distinguished Lecturer.

Causes and Appearance of Noise in Seismic Data Volumes

By SATINDER CHOPRA and KURT J. MARFURT

Seismic data are usually contaminated with noise, which refers to any unwanted features in the data.

These unwanted features may actually be somebody else's signal, such as converted waves in what we think of as "P-wave" data – but more commonly, these unwanted "noise" features provide little or no information about the subsurface, and are referred to as random noise and coherent noise.

Examples of random noise include wave action in a marine environment, wind and vehicle traffic in a land environment and electronic instrument noise in both environments.

There are two types of coherent noise:

- Coherent noise that is not generated by the seismic experiment, such as 60 Hz powerline noise and pumpjack noise.
- Coherent noise that is generated by the seismic experiment, such as ground roll, reverberating refractions and multiples.


CHOPRA


MARFURT

On processed data, noise that looks random in time may be highly organized in space – such as acquisition footprint, which is highly correlated to the acquisition geometry.

The least ambiguous but most difficult to address type of "noise" is the total absence of signal, such as dead traces and lower-fold areas corresponding to the unrecorded offsets and azimuths. Whatever their cause, all these types of seismic noise can result in significant artifacts that may negatively impact subsequent interpretation products, from simple structural and spectral attributes through prestack impedance inversion, to AVAz analysis.

Suppression of Noise

Of all the types of noise, random noise – or coherent noise that appears random – is the easiest to suppress.

The mean filter is the simplest and most familiar noise suppression filter. These filters simply represent the arithmetic running average of a given number of spatial samples, usually "3" for 2-D data or "5" for 3-D.

Larger filters are most efficiently implemented by cascading, or reapplying, the filter to a previously filtered version of the data multiple times. Mean filters can be directly applied to time structure maps and horizon slices through seismic amplitude or attribute volumes.

In 3-D, mean filters should be applied along structure rather than along time slices, generating a "structure-oriented" filter. In general, mean filters centered about the trace to be filtered will smear lateral discontinuities in the seismic data, and should be avoided.

In contrast, a structure-oriented median filter not only suppresses random noise, but will preserve lateral reflector discontinuities.

The median filter picks up samples within the chosen aperture along the local dip and azimuth and replaces the amplitude of the central sample position with the median value of the amplitudes. Principal component filters go one step further by using more than the five (or more) samples along structure dip and azimuth, but also a suite of 2K parallel five-sample slices above and below the target sample.

Mathematically, the principal component generates a five-sample pattern that best represents the lateral variation in amplitude along the 2K+1 slices. In the absence of high amplitude artifacts in the data in general, the principal component filter accurately preserves lateral changes in seismic amplitude and rejects noise.

All of these filters can be run in an edge-preserving manner.

The simplest way to preserve edges is to simply compute the location of the edges using a coherence or Sobel filter algorithm sensitive to discontinuities. The desired filter is then applied only to those areas where the coherence falls above some user-defined value.

A slightly more complicated way to preserve edges is to evaluate the standard deviation (or alternatively, the coherence) in a suite of overlapping windows that include the analysis point. Then the mean, median, principal component or other filter is computed in the window with the smallest standard deviation or coherence and mapped to the desired sample.

We show the application of a principal component structure-oriented filtering to a data volume through a representative seismic section in figure 1.

The input data in figure 1a shows good reflectors with subtle cross-cutting noise. The filtered section (figure 1b) exhibits improved event continuity and preserved amplitude.

To ensure that no useful reflection detail is lost in the filtering process, we take the difference volume and examine it.

As seen in figure 1c, there are no reflection events that have been rejected. Instead, we see random noise as well as inclined broken noise patterns. This steeply dipping noise is common to most seismic data volumes and is associated with the migration of shallow reflections, diffractions and coherent noise that have been insufficiently sampled, or aliased, in the spatial acquisition design.

Modern "high density" acquisition directly addresses these sampling problems and results in superior images for the interpreter.

Structure-oriented filtering is widely used in the industry and has also found its way into most commercial workstation interpretation software packages. It usually works fine in most cases, and so the interpreters tend to use it all the time, irrespective of the quality of the input seismic data.

We wish to elaborate on this aspect and emphasize that suppression of noise should be done carefully, only after examining the quality of the data. Parameters can be important. In general, one should avoid running filters vertically, since this will result in lower frequency output (figure 2).

In this example, the edge-preserving, structure-oriented filtering was run with the default parameters in a popular commercial seismic interpretation package. These default parameters result in smoothing not only along dip, but also perpendicular to dip, thereby acting as a low pass filter.

One should always examine the rejected noise by computing the difference between the input and output as shown in figures 1c and 2c.

In Figure 3a, we show a small segment of a seismic section close to the edge of the survey. The data at the edge of the survey to the right side of the display has migration smiles. Seismic migration takes each sample of the input data and maps it to a 3-D ellipsoid in the output data.

If the sampling of the surface data

Continued on next page

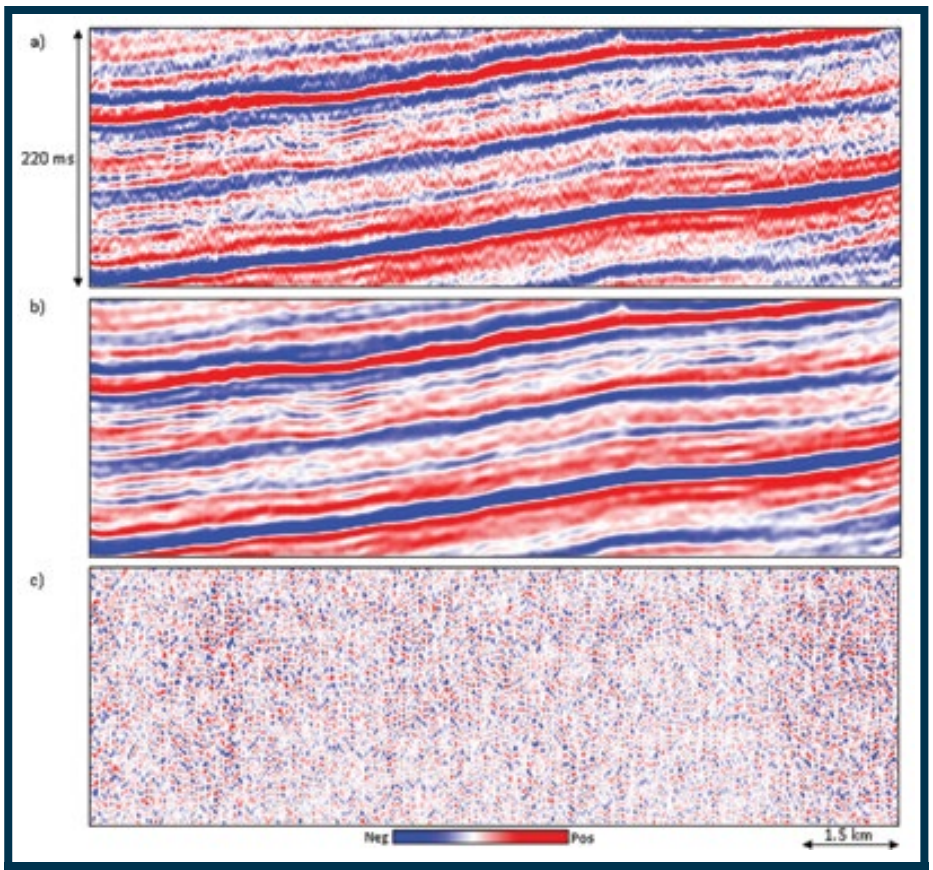

Figure 1 – Vertical slice through seismic amplitude volumes (a) before, and (b) after principal component structure-oriented filtering, and (c) the difference section. Notice the broken inclined wave trains of noise are seen in the difference section, and the display after structure-oriented filtering looks clean with the reflections much more coherent. (Data courtesy of Arcis Seismic Solutions, TGS)

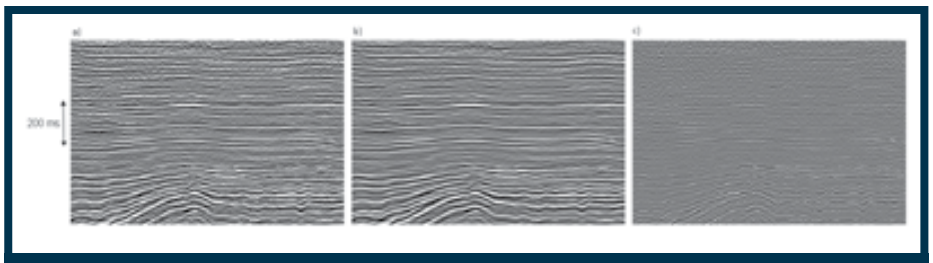

Figure 2 – Vertical slices through legacy data acquired over Vacuum Field, NM (a) before, and (b) after edge-preserving structure-oriented filtering using the default parameters in a commercial software implementation. (c) The difference between the two, showing the desired rejection of the steeply dipping migration artifacts, but also of the higher frequency components of the seismic signal. (Data courtesy of Marathon Oil Co.)

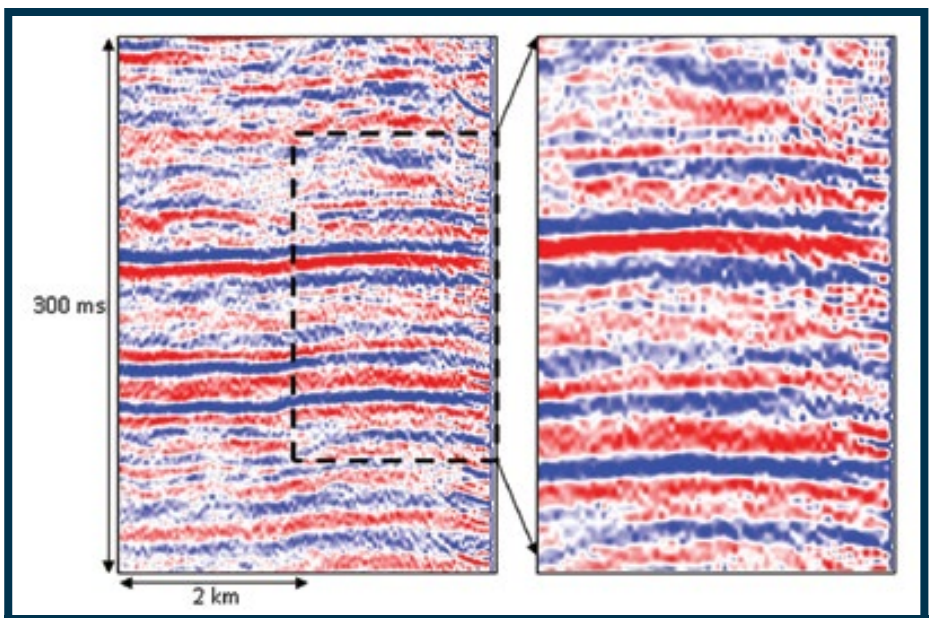

Figure 3 – Segment of an inline seismic section very close to the edge of the survey. Notice the edge effect to the right (migration smiles), as well as the noise in the data. A zoom of the portion in the dashed rectangle shows the noise bursts and the incoherency of the reflections. (Data courtesy of Arcis Seismic Solutions, TGS)

Editor's note: AAPG member Kurt J. Marfurt is with the University of Oklahoma, Norman, Okla.

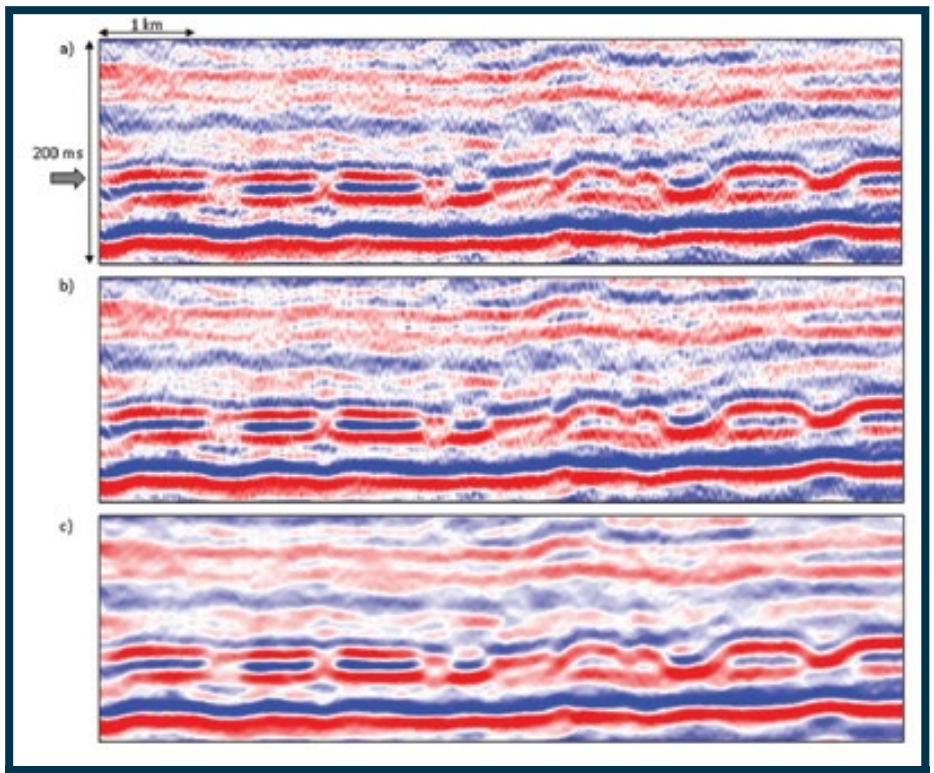

Figure 4 – Segment of a seismic section from (a) the input seismic volume, (b) the same data after structure-oriented filtering, and (c) the same input data after 3-point median filtering. Notice the fine amplitude bursts are taken care of much better with median filtering than structure-oriented filtering. (Data courtesy of Arcis Seismic Solutions, TGS)

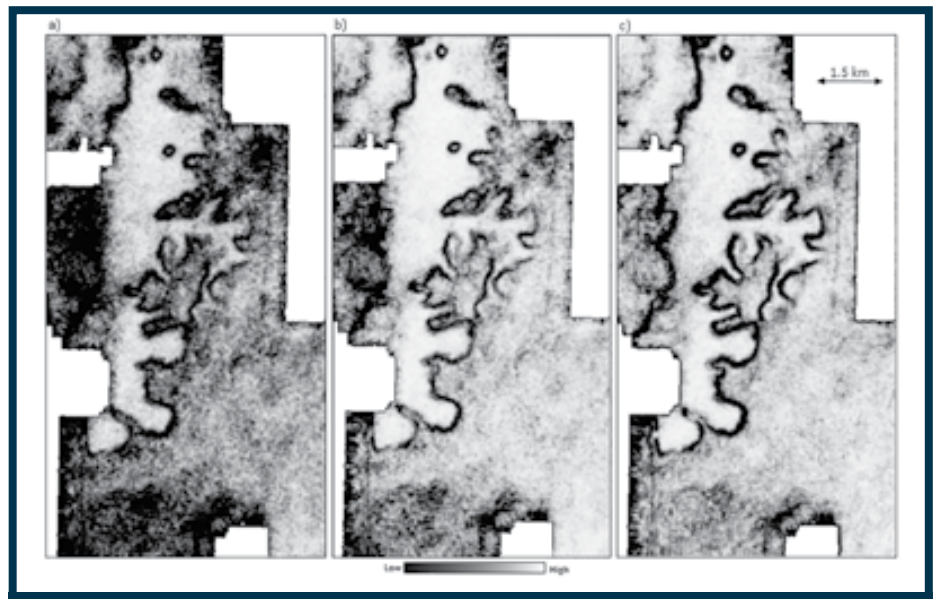

Figure 5 – Time slices (at 1362 ms) from the coherence volume generated on (a) input seismic data volume, (b) input seismic data volume with structure-oriented filtering and (c) the input with median filter. Notice the clarity on the coherence run on median filtered output as compared with coherence run on input data with structure-oriented filtering. (Data courtesy of Arcis Seismic Solutions, TGS)

Continued from previous page

is sufficiently dense, these smiles constructively interfere along reflectors and diffractors and destructively interfere elsewhere, thereby forming the migrated image.

If the surface data are coarsely sampled the steeper limbs of the smiles fail to destructively interfere, resulting in the steeply dipping artifacts seen in figures 1 and 2.

If the data goes abruptly to zero, such as at the edge of a survey or in a no-permit zone, there are no additional smiles to destructively interfere, leaving the edge effects seen in figure 3.

High amplitude spikes present in the data also generate smiles, which appear as a number of small amplitude bursts scattered throughout the section in a random way. This is clearly seen on the zoom of a small portion of the section shown in figure 3b.

When such amplitude bursts, or spikes are randomly present in the data, principal component structure-oriented filtering may not be the best way to enhance S/N ratio.

In figure 4a we show a segment of a section from seismic data that has a significant distribution of high amplitude noise bursts distributed in a random manner.

The principal component structure-oriented filter application is shown in figure 4b.

Notice the amplitude bursts have been toned down somewhat after the filter application, but have not been entirely suppressed.

A similar application of median filtering to the same data shown in figure 4c demonstrates the complete suppression of the noise bursts. By construction, the principal component filter generates a spatial pattern that best represents the energy within suite of 2K+1 vertical windows.

In the extreme case where one of the traces is a high amplitude spike, the most energetic pattern will be the value 1.0 at the spike trace location and zero at the other locations.

Counterintuitively, the principal component filter in this case will preserve the noise and reject the signal. The data in figure 4 are not quite this bad, but have sufficiently high amplitude noise that it contaminates the pattern.

In contrast, the non-linear median filter is constructed to reject anomolously strong negative and positive spikes, resulting in the improved image in figure 4c. The coherence attribute using energy ratio algorithm was computed from the input and the two filtered outputs in figure 4, and their comparison is shown in figure 5.

Notice the sharp definition of the features see on the slices after median filtering as compared with the other two.

▸ Dipping noise.

Steeply dipping noise, sometimes due to shallow backscattered ground roll can also riddle seismic data. If left in the data, this noise will create artificial patterns on the computed attributes. This noise can be suppressed with dip filters.

In figure 6 we show the input and the dip-filtered result.

While the filtered result looks cleaner and reflections look continuous, there is always the danger of removing signal by filtering and should be checked by computing the difference volumes.

▸ Acquisition footprint.

Acquisition footprint refers to linear spatial grid patterns seen on 3-D seismic time slices. Commonly seen on shallower time slices or horizon amplitude maps as striations, they can mask the actual amplitude variations under consideration for stratigraphic interpretation, AVO analysis and reservoir attribute studies.

In land data, acquisition footprint often results in seismic data when the offset and azimuth distribution varies from CMP bin to CMP bin.

In marine data, repeatable variations in offset and azimuths often occur due to cable feathering. Spatially periodic changes in offset and azimuth give rise to spatially periodic variations in the stacked data, sometimes from AVO and AVAz

See **Patterns**, page 54

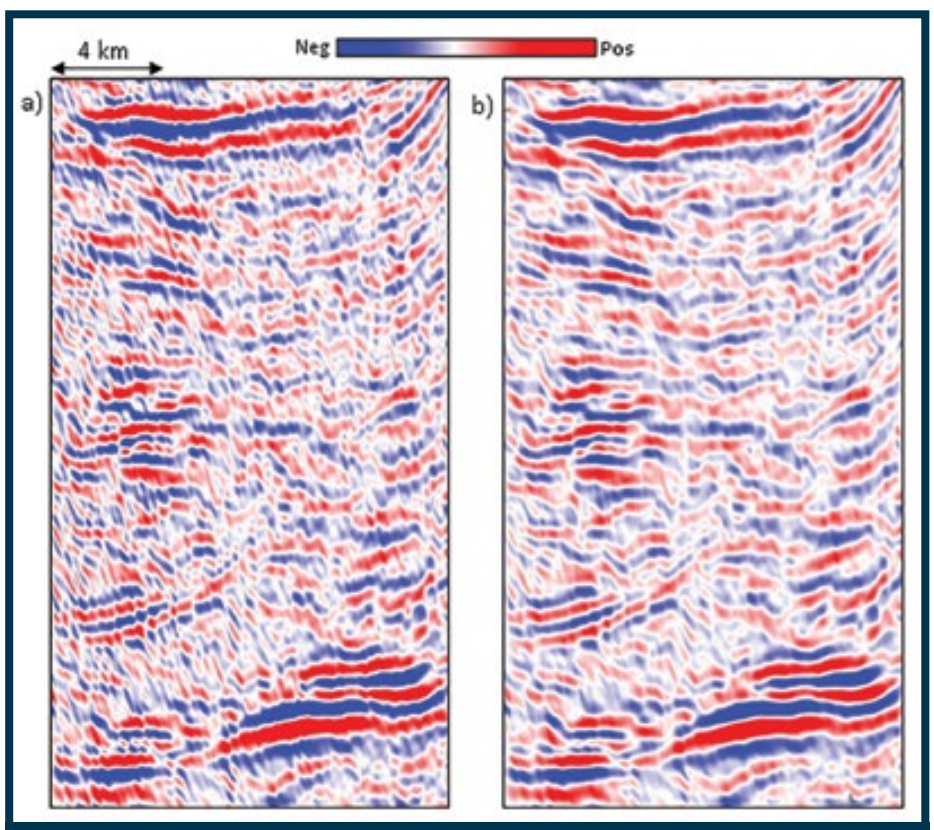

Figure 6 – Segment of a seismic section from (a) the input seismic volume, and (b) the same data after filtering coherent noise using a dip filter. Notice the dipping noise has been suppressed and the reflections are looking more coherent and continuous. (Data courtesy of E&B Resources)

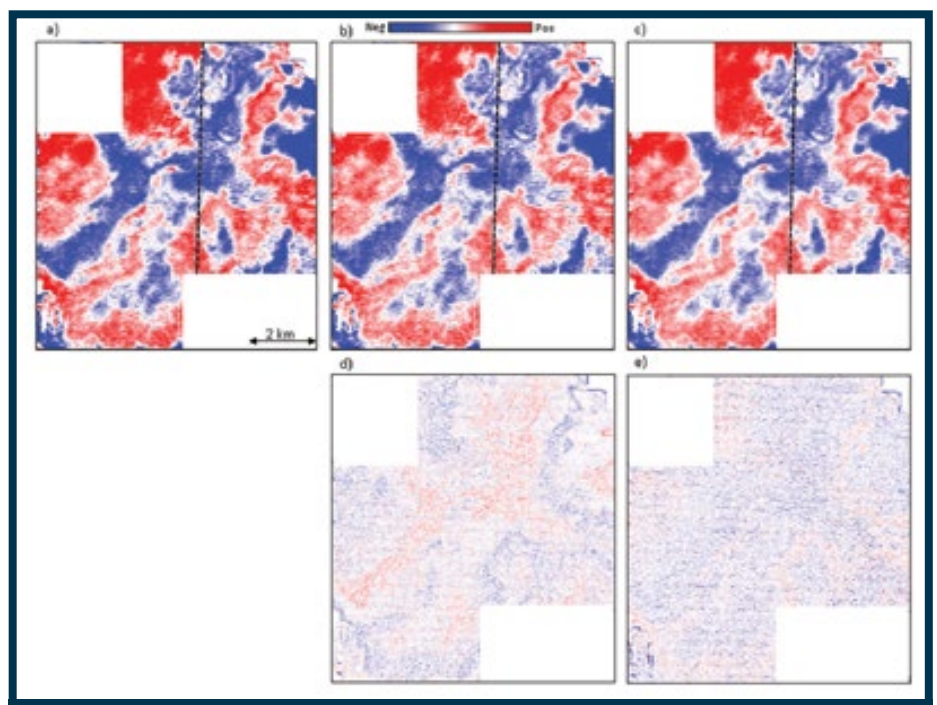

Figure 7 – Time slice at t=1044 ms through seismic amplitude volumes (a) before, (b) after principal component structure-oriented filtering, and (c) after 3-point median filtering. Notice the background noise is better suppressed by the median filtering than by the principal component structure-oriented filter. However, while the E-W acquisition pattern seen seems to be toned down a bit after filtering, it is not eliminated completely. The black dashed line shows the location of the crossline segments. The difference displays between (a) and (b) and (a) and (c) are shown in (d) and (e) respectively. (Data courtesy of Arcis Seismic Solutions, TGS)

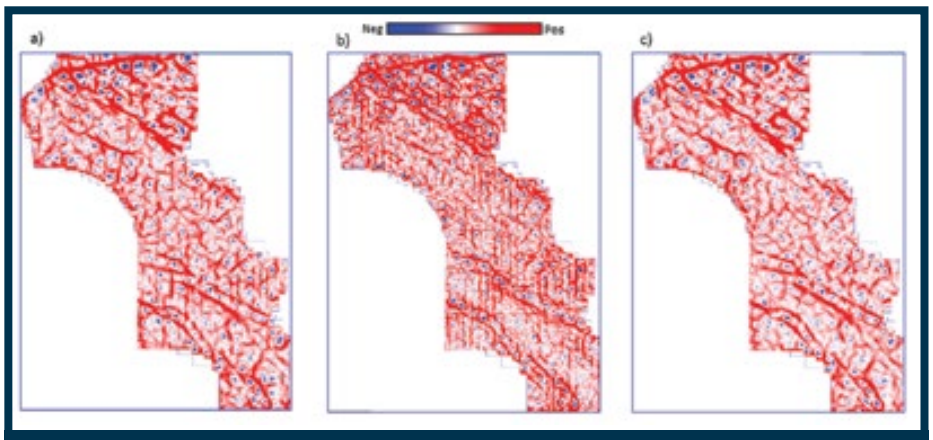

Figure 8 – Time slices through most-positive curvature volumes generated at (a) long-wavelength, (b) intermediate wavelength, and (c) long-wavelength after foot-print filtering. Notice the N-S footprint pattern has been suppressed after k_x-k_y filtering of the input data. (Data courtesy of Arcis Seismic Solutions, TGS)

Patterns
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effects, but more often from subtle errors in velocities that result in a different stack array response.

If the pattern is vertically consistent, and has a similar wavelet to neighboring traces, principal component structure-oriented filtering will consider this consistent amplitude pattern to be signal, not noise, and preserve it.

In figure 7 we show the application of both principal component and median filters on seismic data, which has an E-W acquisition pattern.

Both the filters tend to reduce the effect somewhat, but do not suppress it entirely. The different slices confirm this.

One way to suppress the footprint is to first analyze the pattern in the k_x-k_y wavenumber domain, and then design filters to remove the unwanted patterns. Of course, one runs the risk of also removing the authentic signatures of fractures in the data that have the same orientation as the footprint, and so such filtering needs to be applied with care.

We show one such application in figure 8, where the most-positive curvature time slices are shown from the input seismic data at a long-wavelength computation (figure 8a) and at an intermediate wavelength computation (figure 8b). Both these displays show the N-S oriented acquisition footprint patterns.

The equivalent display from the most-positive curvature (long-wavelength) computed on the footprint-filtered version of the seismic data is shown in figure 8c.

Notice the absence of the N-S footprint striations.

▸ Regularization of seismic data with 5-D interpolation.

Continued on next page

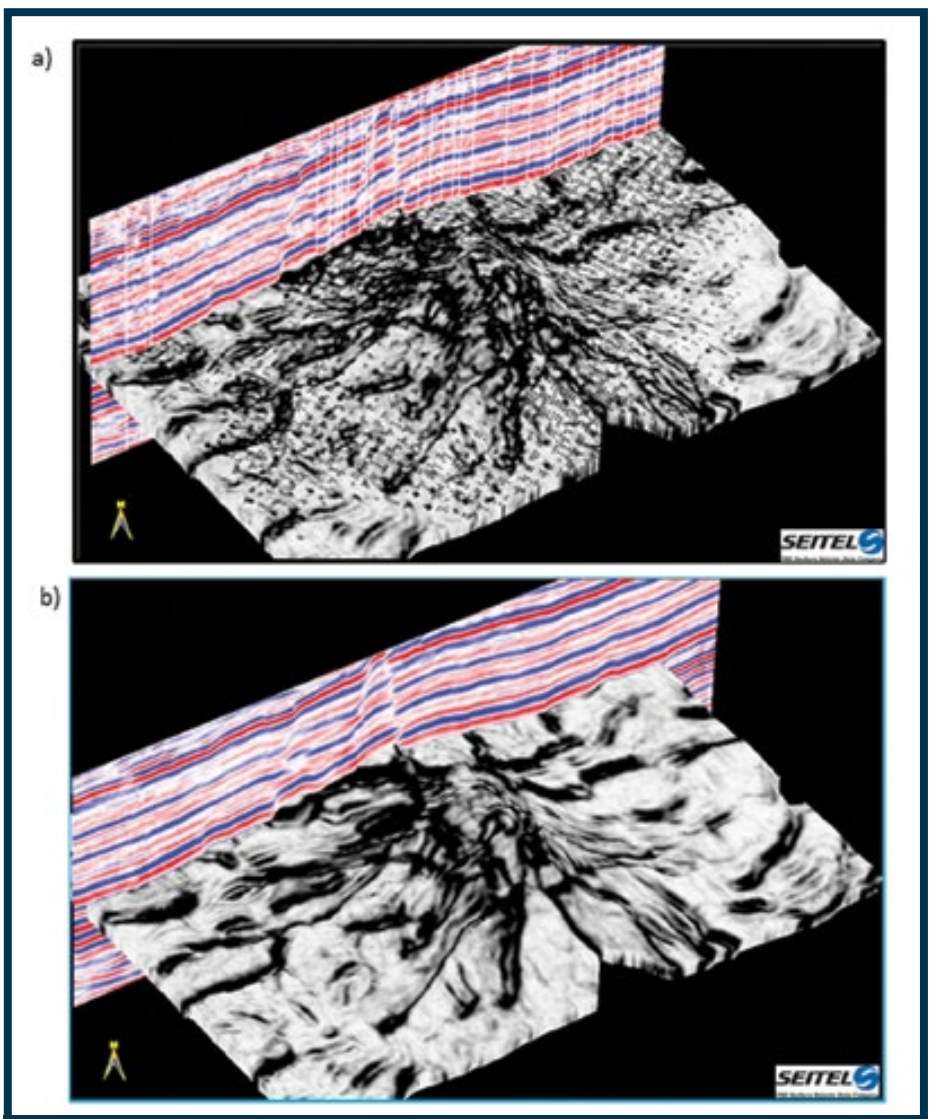

Figure 9 – Chair displays with the vertical as seismic and the horizontal as stratal slices from the coherence volumes (a) before, and (b) after 5-D interpolation. The missing traces in the seismic have been predicted and the coherency of the reflections looks much better. The coherence attributed generated from the interpolated data also looks much better. (Data courtesy of Seitel Data)

Continued from previous page

Seismic attributes computed from sub-optimally sampled seismic data or data with missing traces give rise to artifacts. The ideal way to have an optimally sampled seismic data is to have an optimal shooting geometry followed through in the field.

Practical considerations however, usually yield seismic data that have missing traces, large data gaps or a non-uniform distribution of offsets and azimuths in the bins.

In principle, one might correct for or fill in the missing data gaps by reshooting the data in those areas. In practice, such infill acquisition can be extremely expensive, and is avoided.

The second best approach is to handle the missing data problem in the processing center.

Originally, single or a local few missing data traces can be handled by copying adjacent traces to into the CMP bin. Such simplistic methods were superseded by 2-D and later 3-D triangular trace interpolation methods.

All these methods use the local data to predict the missing data and so are called local methods. They do have a limitation in that they cannot handle large data gaps.

In the last decade or so, global methods for data interpolation have evolved that use more of the available data to populate the missing data. These methods are multi-dimensional instead of one, two or three dimensional, operating simultaneously in as many as five different spatial dimensions (e.g. inline, crossline, offset, azimuth and frequency), and are able to predict the missing data with more accurate amplitude and phase behavior.

As might be expected, these methods are compute intensive and have longer run-times than the local methods.

Such 5-D interpolation methods regularize the offset and azimuth distribution in bins, and hence the simulated acquisition geometry of the seismic data. In doing so they address the root cause of the missing data, and subsequent footprint artifacts.

In figure 9 we show chair displays with seismic amplitude as the vertical sections and coherence as the horizontal sections, before and after 5-D interpolation.

Notice the missing traces in the seismic before 5-D interpolation are all predicted nicely and the reflections looks more coherent.

Similarly, the speckled pattern corresponding to the missing traces on the coherence volume before 5-D interpolation is gone, and the coherence display is amenable to much better interpretation after 5-D interpolation.

In figure 10a we show time slices at t=158 ms, where the acquisition footprint appears prominently on the coherence attribute as striations in the NE-SW direction, masking the reflection detail behind them.

Figure 10b shows the equivalent coherence slice after 5-D regularization, exhibiting considerable improvement in data quality. Similarly, cleaner and clearer curvature displays are derived from data after 5-D interpolation and resulting in more confident interpretation, as shown in figure 10 c to f.

Conclusions

Seismic data usually suffer from different types of noise. Random noise is the easiest to recognize and the easiest to address.

Coherent noise such as acquisition footprint can be more challenging, and result in coherent artifacts on seismic attribute displays that can mask features of

See **Conclusions**, page 59

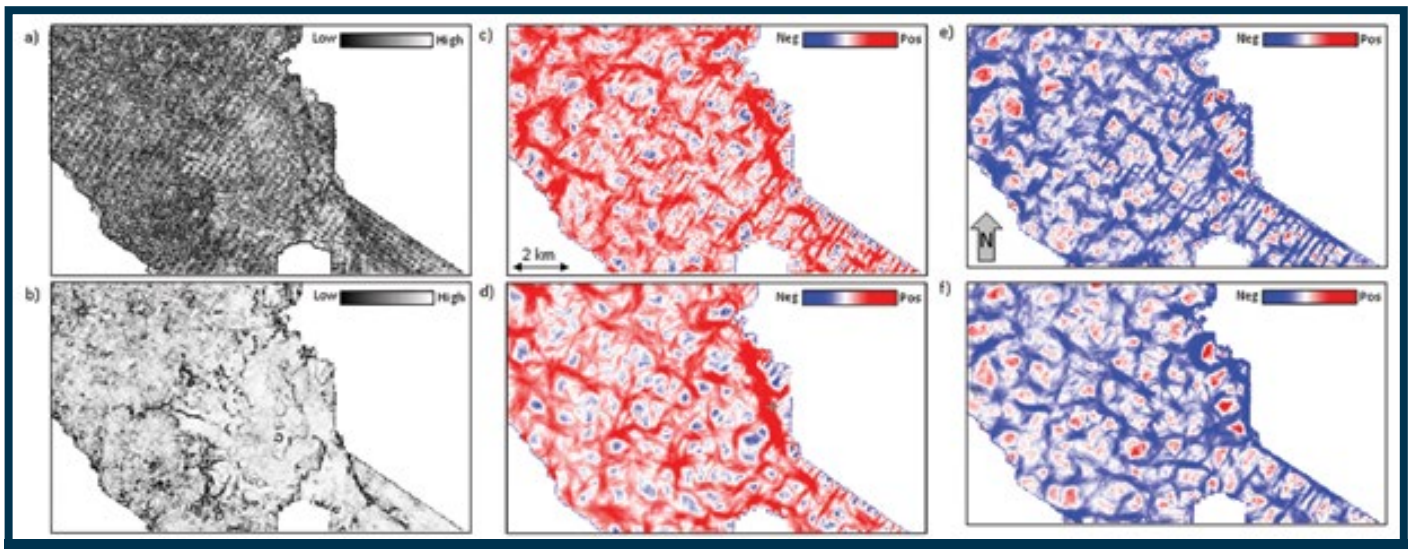

Figure 10: Time slices at 158 ms through coherence volumes (a and b), most-positive curvature (c and d), and most-negative curvature (e and f) computed from amplitude data (above) before, and (below) after 5-D interpolation. Notice the acquisition footprint has been suppressed after 5-D interpolation. (Data courtesy: Arcis Seismic Solutions, TGS)

Edith Allison, director of AAPG's Geoscience and Energy Office in Washington, D.C., can be contacted at eallison@aapg.org; or by telephone at 1-202-643-6533.

Research Benefits Defy Easy Measurement

By EDITH ALLISON, Geoscience and Energy Office Director

Ronald Reagan stated in an April 2, 1988, radio address that " … although basic research does not begin with a particular practical goal, when you look at the results over the years it ends up being one of the most practical things government does."

This widely held opinion has been notoriously hard to verify or quantify, leading to questions about appropriate funding levels.

Given the congressional interest in cutting federal spending on wasteful or ineffective programs, in 2010 Congress asked the National Research Council (NRC) to " … evaluate, develop or improve metrics for measuring the potential impact of research on society ..."


ALLISON

The benefits of basic research are especially hard to measure because the link to new inventions or products may be very long and circuitous.

An additional incentive for the study was the concern that although the United States invests more in R&D than any other nation and has the largest share of research institutions, scientific publications and patents, other countries, including China, are challenging this lead.

The NRC, Division of Behavioral and Social Sciences and Education, Committee on Assessing the Value of Research in Advancing National Goals released the resulting report "Furthering America's Research Enterprise" in pre-publication format in June 2014. The report is available free of charge on the National Academies website, www.nas.edu.

The report looked at basic research, defined as " … experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundations of phenomena and observable facts, without any particular application or use in view."

The research and development pie is divided with 20 percent each to basic and applied research, and 60 percent to development.

The federal government funds about 60 percent of basic research. The private sector supports the majority of applied research and demonstration – and over 60 percent of total research.

* * *

The benefits of basic research are especially hard to measure because the link to new inventions or products may be very long and circuitous.

One example described in the report is Google's 1997 patent application for the page-ranking algorithm that forms the basis of its search function. The patent application credits 20-year-old basic research in a variety of subject areas, supported by the National Science Foundation, the National Institutes of Health and other federal agencies. The patent application also cites analogous social science research in the 1950s and 1960s that showed a person's social status can be tied to the status of people who have a relationship with the person.

The report observed that the American research system is complex, decentralized, pluralistic, competitive, meritocratic and entrepreneurial. This means that it is difficult to determine which types of research, in the absence of other types, would lead to innovations.

In addition, the research system is unlikely to achieve a goal such as more research discoveries with commercial value by changing one or a few of the components of the research system.

In other words, picking winners would not be effective.

The report also details the limitations of efforts to measure research impacts and quality by organizations and government agencies in the United States and other countries. Commonly used metrics include tallying the outputs of specific research projects, such as the number of patents, publications or citations by other authors.

Broader research measures may incorporate both qualitative and quantitative rankings.

The study notes that the U.S. research enterprise has systems characteristics: Results or products may be the result of

Continued on next page

Continued from previous page

interactions between components of a system, not the direct product of a single component.

However, the study committee was confident that the research community can increase its benefits to society by developing new measures to guide research investments, based on understanding of what drives the research system and what makes it so productive.

* * *

The report concluded " … measures can usefully quantify research outputs for many specific purposes, but that current measures are inadequate to guide national-level decisions about what research investments will expand the benefits of science."

Alternatively, the report recommends that understanding and influencing what the report calls the three "crucial pillars" of the research system could be the way to increase the societal benefits of basic research:

- A talented and globally interconnected work force – a work force built by investments in education and worldwide networks allowing researchers to share ideas and resources.
- Adequate and dependable resources – for example, stable and predictable federal funding that attracts and retains researchers, and supports diverse institutions and scientific infrastructure.
- World-class basic research in all major areas of science, which often provides the foundation of knowledge for future economically significant innovations.

In other words: To understand the research "system" you need to understand how knowledge is generated; utilized by well-trained, talented people; disseminated; impacted by external variables such as investment and infrastructure; and utilized by public and private entities.

The report suggests that existing measures could be used to assess each of the three pillars.

For example, the study committee proposes that novel use of data from agencies such as the U.S. Census Bureau and the Bureau of Labor Statistics could measure the movement of researchers and recent STEM graduates that underlie **pillar 1**.

Federal funding (**pillar 2**) is easily tracked and reported by many organizations. The extreme funding variations introduced by the stimulus (the American Recovery and Reinvestment Act of 2009) increases followed by funding cuts under the 2013 budget sequestration are documented, but impacts on the research workforce have evidently not been documented.

Typical measures of world-class stature (**pillar 3**) focus on outputs such as publications, patents and citations, and the quality of research facilities.

* * *

For additional information:

- A related report was released in November 2013 by the Committee on National Statistics, Division of Behavioral and Social Sciences and Education: "Capturing Change in Science, Technology, and Innovation: Improving Indicators to Inform Policy."

See **Capitalizing**, page 59

Distinguished Lecture Tours Announced for 2014-15

By LORRY OLDEFEST, Distinguished Lecture Coordinator

It has a new name, a new energy and a new lineup of experts, all primed to spread geoscience knowledge around the world.

"It" is AAPG's newly named Global Distinguished Lecture Program – emphasis on the "global" – which dates back to 1941 but contuinues to be the Association's flagship initiative for offering the latest in geologic science to AAPG affiliated geological societies and universities.

This year, 14 lecturers, supported with funding throuigh the AAPG Foundation, will spend the next year presenting talks in North America, Canada, Europe, Latin America, Africa, Middle East and Asia-Pacific Regions.

The talks will vary within a wide range of topics, from "Anatomy of a Petroleum Source Rock," "Extensional and Transtensional Rift Basins in California and Mexico" and "An Overview of Pre-Devonian Petroleum Systems-Unique Characteristics and Elevated Risks" to "Human Kidney Stone Formation: Insights from Yellowstone, Roman Aqueducts and the Deep Microbial Biosphere." So, whatever your area of focus, there should be something of interest for everyone.

Most tours last two-three weeks. The tours begin this month and continue through May.

This year's slate of Distinguished Lecturers includes:


BUSBY


CLARKE


FOUKE


HALE


HAMPSON


KATZ


KENTER


LANDER


MANNING


MILLER


SCHIEBER


SMITH


TOWERY


WOJCIK

- **Cathy Busby**, professor tectonics, sedimentology and volcanology, University of California, Santa Barbara, Calif.
- **Don Clarke**, consultant, California (AAPG Ethics Lecturer).
- **Bruce Fouke**, director of the Roy J. Carver Biotechnology Center and professor of geology, microbiology and the Institute for Genomic Biology, University of Illinois, Urbana-Champaign, Ill. (Roy M. Huffington Lecturer).
- **David Hale**, Colorado School of Mines, Golden Colo. (AAPG/SEG Inter-Society Lecturer).
- **Gary Hampson**, reader in sedimentary geology, Imperial College, London, England (Allan P. Bennison Lecturer).
- **Barry Katz**, Chevron fellow and team leader – Hydrocarbon Charge, Houston (J. Ben Carsey Lecturer).
- **Jeroen Kenter**, senior carbonate stratigrapher/sedimentologist, ConocoPhillips, Houston.
- **Rob Lander**, scientific adviser, Geocosm, Durango, Colo., (Haas-Pratt Lecturer).
- **Phil Manning**, professor of natural history and director of Interdisciplinary Centre for Ancient Life, University of Manchester, England.
- **Ken Miller**, distinguished professor, Department of Earth and Planetary Sciences, Rutgers, Piscataway, N.J. (Dean A. McGee Lecturer).
- **Juergen Schieber**, professor, geological sciences, Indiana University, Bloomington, Ind.
- **Taury Smith**, consultant, Smith Stratigraphic, Albany, N.Y.
- **Lisa Towery**, senior geologist, BP America, Houston.
- **Chris Wojcik**, geophysical adviser with deepwater exploration, Shell Exploration and Production Co., Houston (Shell Lecturer).

Please check the AAPG website for each lecturer's topics (several offer multiple options), tour dates and travel locations, at www.aapg.org/career/training/in-person/distinguished-lecturers.

Capitalizing
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▸ The Senate Committee on Commerce, Science and Transportation held a hearing on "the Federal Research Portfolio: Capitalizing on Investments in R&D" on July 17, 2014. Witness testimony and an archive of the webcast of the hearing are available at the committee website. It was Neal Lane, Rice University professor of physics and astronomy and witness at this hearing, who quoted President Reagan on the value of research.

▸ Later this year Congress may consider the America Creating Opportunities to Meaningfully Promote Excellence in Technology, Education and Science Reauthorization Act of 2014, S. 2757. The bill, introduced in late July by six Democratic senators and informally called America COMPETES, authorizes basic and applied research at several federal agencies including the NSF. Information about the bill is at Congress.gov.

Taking action:

▸ Every spring AAPG organizes congressional visits by its members. This is an opportunity to discuss with Congress and federal agencies issues such as petroleum geoscience research needs, access to federal lands, or the impact of federal regulations on oil and gas operations.

▸ Every September, AAPG, the Geological Society of America, the American Geosciences Institute, the American Geophysical Union and other geoscience associations host Geoscience-Congressional Visits Day (Geo-CVD), when their members visit their representatives and senators to discuss research and policy priorities.

For information about these events, contact Edith Allison, at eallison@aapg.org.

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The monthly list of AAPG Foundation contributions is based on information provided by the AAPG Foundation office.

Conclusions
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interpretation interest.

We have emphasized the importance of conditioning the data in terms of noise filtering as well as regularizing the data with 5-D interpolation. We have suggested that the input data should first be examined carefully to understand the type of noise contaminating them, and then choosing an appropriate method of filtering.

Random noise may be handled using principal component structure-oriented filters, but when spikes or sharp amplitude bursts are present, they could be handled better with nonlinear structure-oriented median filters.

Inclined coherent noise can be handled with dip filtering.

Acquisition footprint or missing data issues arising out of non-uniformity in the geometry of the seismic data could be handled with 5-D interpolation.

Once such problems are diagnosed and handled for the input seismic data, seismic attributes computed on them would definitely be more meaningful, would display better and thus lead to more accurate interpretations.

Editor's note: Regions and Sections is a regular column in the EXPLORER offering news for and about AAPG's six international Regions and six domestic Sections.

REGIONSandSECTIONS

From left: U Tin Myint, former director-offshore operations, Myanma Oil and Gas Enterprise; Win Swe, former geology professor; Adrienne Pereira; and U Kyaing Sein, vice president, Myanmar Geosciences Society.

AAPG Holds Inaugural Myanmar Conference

By ADRIENNE PEREIRA, Programs Manager, AAPG Asia-Pacific Region

AAPG held its first conference in Myanmar in August. The technical program titled "Tectonic Evolution of Myanmar and its Basin Development with Special References to its Petroleum Occurrences" was attended by 238 local and international delegates from 16 countries.

With recent geopolitical changes leading to international interest and investment, Myanmar has come into the spotlight for its potential for new plays and redevelopment of existing fields. The focus of the conference was for a broader and deeper understanding of the geology of Myanmar and its impact on the distribution of hydrocarbons.

The inaugural conference consisted of 25 oral presentations and nine poster presentations with several keynote addresses from prominent speakers such as U Myo Myint Oo, managing director of Myanma Oil and Gas Enterprise; Ian Metcalfe, University of New England; Win Swe, Myanmar Geosciences Society; Chris Morley, Chiang Mai University and Claude Rangin, Nice University, France.

The conference also was sponsored by prominent names in the industry: Petronas, Shell, Chevron, Total, Woodside, Dolphin Geophysical, Geokinetics, Terrex Group, Ion, Daewoo International, Schlumberger, Myanmar Development Co., and the European Association of Geoscientists and Engineers.

AAPG would like to thank all the sponsors for contributing to the success of the event.

INMEMORY

James Warren Caylor, 85
Oklahoma City, Aug. 8, 2014
Aureal T. Cross, 97
Bloomfield Hills, Mich., Dec. 2, 2013
William James Davies, 90
Conroe, Texas, May 16, 2014
Richard Brownley Gayle Jr., 85
Houston, June 13, 2014
C. Clare Gregg, 86
Columbine Valley, Colo.
April 24, 2014
John Paul Land, 88
Houston, July 28, 2014
Roy Edgar Matthews, 84
Oklahoma City, Aug. 12, 2014
Frederick Nelson Murray, 79
Tulsa, July 20, 2014
Sam Park III, 81
Kingwood, Texas, June 30, 2014
Claude Hartwell Roberts Jr., 86
Houston, July 17, 2014
Scott Evans Wilson, 63
Austin, Texas, Jan. 16, 2014

(Editor's note: "In Memory" listings are based on information received from the AAPG membership department.)

Editor's note: AAPG member Terry Engelder, professor of geosciences at Penn State University and a leading authority on the Marcellus gas shale play, is finishing his 2013-14 AAPG Distinguished Lecture tour this month with talks in the Middle East Region. One of his lecture topics deals with hydraulic fracturing.

Commentary

Truth and Lies About Hydraulic Fracturing

BY TERRY ENGELDER

During my recent 11-country AAPG Distinguished Lecture tour in Europe I had many requests for "The Environmental Realities of Hydraulic Fracturing: Fact versus Fiction," an analysis of the root causes of the global pushback against hyrdraulic fracturing, commonly known as "fracking." This came as no surprise considering the sensitivity to the prospect of shale gas exploration and extraction in much of Europe. My objective was to address the public fears that drove moratoria and bans on hydraulic fracturing in places as different as New York State, the United Kingdom and France.

ENGELDER

Central causes of public fear arose in America because of a combination of early mistakes by industry and purposeful disinformation from activists and others seeking to profit from such mistakes.

Disinformation was easily spread beyond America to places with nothing more than a modest gas industry experience. Countries with less generous property rights laws than America were particularly vulnerable to disinformation.

"Environmental Realities: Fact versus Fiction" boils down to a clash between the recalcitrant notion that the worst will happen when the gas industry shows up, and an American optimism that gas can be produced at maximum benefit and minimum risk.

Several Europeans stated that hydraulic fracturing was not welcome until it was safe. While everyone wants a safe industry, safety is never absolute.

According to the Pennsylvania Department of Environmental Protection (PA-DEP), the water chemistry in only 30 private water wells spread among more than 7,000 Marcellus gas wells drilled in Pennsylvania over the past seven years was affected by industry and all were cases of methane migration.

While a rate of less than five water wells per year is too high, this occured in a state where more than 1,000 people are killed annually in automobile accidents. Although methane is dangerous when allowed to accumulate as indicated by one fatal drill-rig explosion during the past seven years, it is not toxic.

Despite a fatality rate at least 7,000 times larger over seven years, a poll among Pennsylvanians might identify driving as the safer activity!

My research on natural hydraulic fracturing in gas shale dates back to the 1970s, when both the horizontal drilling of shale source rocks and the use of high-volume hydraulic fracturing were first attempted in the United States.

Although both techniques date back 35 years, none of this early work on fracturing made much of an impression on the public.

If this long history of horizontal drilling and high volume hydraulic fracturing were recognized, it would have been hard to make the case that either is a new or dangerous practice.

Risks and Rewards

The process by which hydraulic fracturing entered the general consciousness may have started about 2007 with my calculation of the technically recoverable reserves in the Marcellus gas shale of the Appalachian Basin.

In late 2007 I went to the news media with my results, receiving a great deal of public attention. At that time the term "fracing" or "fracking," was not part of the English language; within two years it had become shorthand for gas extraction by horizontal drilling and high-volume hydraulic fracturing, and most people now know what "fracking" is.

In Europe, I was frequently asked, "How can you be so certain (about hydraulic fracturing)?"

As Voltaire said: "Doubt is not a pleasant condition, but certainty is absurd." Science is not capable of certainty beyond having a sense of when others are mistaken.

However, it is not a mistake to point out that shale gas comes with risk along with reward.

As the automobile fatalities example shows, people don't do a very good job of normalizing risk. When asked for absolute numbers on risk, all I can do is point to the millions of hydraulic fracture treatments and stimulations undertaken already, resulting in a modest number of examples of groundwater contamination from subsurface sources, virtually all from methane leaking along the cement-bedrock contact inside a borehole. Risks outside methane leakage come from poor surface management of fluids in the form of spills and leaks.

Air quality is at risk, and, ultimately, burning methane leaves a carbon footprint. These are concerns. The leaks need be found and fixed – but replacing coal-fired power plants with natural gas led to a significant reduction in America's carbon footprint over the past five years, according to the EIA.

This good news does not mean that mankind should discontinue its march toward a larger renewable energy portfolio. Even then, gas-fired turbines are the most immediate solution to maintaining reliable electricity generation when either solar and wind fail to meet demand.

A Number of Mistakes

Industry was responsible for six major "mistakes" during the early days of high-volume hydraulic fracturing in the Appalachian Basin.

I use the term "mistake" because each might have been anticipated – but only by someone with great clairvoyance. None were a manifestation of single events like the engineering carelessness of the Macondo well blowout.

They did, however, create a breeding ground for amplifying public fear of the unknown.

Continued on next page

Continued from previous page

▶ Arguably, the most serious mistake was the failure to establish baseline water chemistry before drilling campaigns.

Many chemical elements (e.g. iron, magnesium, potassium) and compounds (e.g. methane) are dissolved in drinking water, but when water chemistry is measured after the arrival of industry, there is a belief that these chemicals, particularly methane, result from drilling.

Traditionally, the first oil wells in a region were drilled where oil is leaking to the surface. Likewise, gas leaks are associated with the great gas basins in the world, including the Appalachian Basin where there are several towns named Burning Springs. Methane was there all along but industry failed to present these details to the public prior to drilling.

Through the history of the O&G industry in the United States, regions that leaked gas exclusively were not nearly as interesting as those that leaked both oil and gas.

Pennsylvania, for example, had a long history of flaming faucets and bubbling streambeds, although the gas was not usually concentrated sufficiently in groundwater to manifest itself in drinking water. Intensified drilling in 2008 produced a heightened sensitivity to methane in groundwater, but with no baseline, it was impossible to know whether, and how much, methane resulted from this drilling.

Pennsylvania law held operators responsible for the methane in groundwater within 1,000 feet of a gas well, regardless of whether it was their fault.

▶ The second industry mistake involved the extent to which casing was cemented.

Early on, surface and intermediate casing was completely cemented but as much as 5,500 feet of open hole was left outside the production casing, as traditionally done in sparsely populated parts of the country with few water wells near gas ones.

This is fine if the overburden section is not gas-charged – but in northeastern Pennsylvania the overburden contains Upper Devonian coals, full of methane gas, which flowed into the open holes and in some cases likely increased groundwater concentration by leaking along poorly cemented gas wells.

Industry no longer leaves open-hole production casing, at least below the intermediate casing string.

▶ The use of air-drilling to penetrate the vertical legs of Marcellus gas wells was another error.

The pressure of air blowing into more permeable aquifers was sufficient to drive methane toward nearby water wells. It also increased the natural turbidity in groundwater, which often worries people.

▶ A fourth mistake was to lobby for elements in the Energy Policy Act of 2005, which allowed hydraulic fracturing companies to keep their additives proprietary.

The public feared that groundwater would become contaminated by unknown, possibly toxic, chemicals, and wanted to understand exactly what and how much was being pumped into the ground.

There also was the (inaccurate) perception that this act exempted the industry from Clean Water and Clean Air Acts. The industry elected to reveal the details of additives on a website, "Frac Focus," and, while posting volume and chemical composition was voluntary, most operators in the Appalachian Basin have joined in an attempt to become more transparent.

▶ The industry disposed of flowback in large enough volumes to trigger minor earthquakes in Ohio and Texas, which naturally played into the public fear.

Water under pressure flowing along faults reduces the frictional strength sufficiently to cause slip; triggering a large earthquake by injecting water was even the plot of a James Bond movie.

USGS studies confirmed there is a relationship between the injected volume of water and earthquake size, but showed that it was not possible to trigger a destructive earthquake with the amount of water used during fracturing – incidentally proving the implausibility of the James Bond plot.

▶ The sixth mistake involved water management issues associated with potentially leaking open pits, leading to the fear that groundwater could be contaminated if a lined pit was punctured or seals failed.

Presently, only fresh water is stored in open pits. Any flowback is contained in enclosed "frack" tanks where the chance of leaking is near zero.

Purposeful Disinformation?

Public anxiety arising from these very real mistakes was easily manipulated and magnified by activists who either did not know better or sought to profit by playing to this fear.

The most egregious case of purposeful disinformation being used to manipulate the public is found in the closing scene of the movie "Gasland," where a tap is lit.

In fact, the owner's water well was drilled though a coal bed giving off methane, and the film's producer admitted knowing that the methane in this movie scene had nothing to do with hydraulic fracturing.

Public fear also can be manipulated by famous people.

Movie star Matt Damon was quoted as saying that "Everyone knows that fracking poisons the water and air," adding that fracking " … tears apart local communities and subverts democracies."

Yoko Ono was quoted in the media as stating categorically that, "Fracking kills." Subsequently, signs declaring that "fracking kills" have shown up regularly at protest rallies in many places worldwide.

The most common prop at protest rallies has been the jug of rusty, brown water – easily transported and, unlike the flaming faucet, looking nasty enough to amplify fear that hydraulic fracturing is poisoning water.

Rusty, brown water is a natural product of the oxidation of dissolved iron. Tests suggest that nearly half the water wells in parts of Pennsylvania have enough dissolved iron in the groundwater to make it turbid when exposed to atmospheric oxygen, a process accelerated by pumping wells dry.

In fact, the U.S. EPA tested one water well repeatedly and found the water safe to drink. Later, the owners admitted pumping their water well dry to supply turbid water when visitors came knocking.

* * *

In summary, public pressure was largely responsible for political decisions to place moratoria or bans on hydraulic fracturing.

In a sense, industry was directly responsible for these political decisions because of early mistakes, making it easy for activists using purposeful disinformation to further cement a negative public position relative to "fracking."

Letters to the editor should include your name and address and should be mailed to Readers' Forum, c/o AAPG EXPLORER, P.O. Box 979, Tulsa, Okla. 74101, or fax (918) 560-2636; or e-mail to forum@aapg.org. Letters may be edited or held due to space restrictions.

Academic Suggestions

I read with interest the article quoting three academics regarding "State Geology Departments Struggle to Stay Afloat" (August EXPLORER). In general, I agree with their observations and assessment.

However, two possible solutions were implied but understated.

One possible solution to the budget problems and survivability is for geology departments to transform themselves into larger schools with separate departments of geology, geography, atmospheric sciences and environmental sciences under a new umbrella. Deans like this because it means dealing with one school leader instead of four department heads. Certain functions like clerical pools and accounting can be housed in the school office, creating savings.

Most importantly, schools are harder to eliminate than departments.

A second possible solution is to form an alumni geology foundation, with an alumni advisory board to guide the department and help raise funds. Those funds can be used to leverage administrative sources of funding as a match.

The alumni advisory board members also can serve as effective lobbyists for departments with university administrators.

George Devries Klein
Barrigada, Guam

More Testing, Please

Science and scientists have held a revered position in human society since the end of the Inquisition, but their elite status has eroded over the last decades. The brutal climate debate is only the latest in a series of scientific battles that undermine scientific authority because they have entered politics.

More than a half-century of participation in the sciences – including academia, government and industry – permits me to see events from a time perspective not possible for younger scientists.

I have been on the "wrong" side of several popular scientific issues that have since been resolved, and for transparency, I am on the skeptic side of the climate change debate because the data indicates only a relatively minor and local human influence on earth climate.

My first experience was a simple scientific argument about continental drift that persisted from the 1920s to 1965. During my doctoral oral examination, professor Clemens, the vertebrate paleontologist, asked me to explain the vertebrate fossil evidence for and against continental drift. He was firmly against drift. I responded with "I know how you feel about this, but ... " and went on to build the observational case for continental drift – data that could not be explained by any other mechanism.

The faculty and my adviser were aghast, but I was the only one in the room who had read all the relevant literature.

The next year professsor Carl Dunbar supported my outrageous idea when I queried him about his hypothesis that there had been a landmass off the northeast coast of the United States. He pointed out that current directions and sedimentary wedges in the Devonian Catskill delta could only have been derived from an eastern source.

Two years later J. Tuzo Wilson gave his famous paper on a new class of faults, transform faults, and the scientific rout was on. A mechanism to move continents had been discovered. We now call continental drift "plate tectonics," and it became our unified field theory of earth tectonics.

In 1963, there would have been a 99 percent consensus that continental drift was not a valid theory. Five years later, there was a likely 95 percent consensus that continents moved. The message is clear: consensus is meaningless and data lead the way in advancing science.

The debate was resolved without public rancor because it was restricted to our profession. No politics or global agendas were involved. Nor was any money to be earned from taking one position or another.

In 1984, research demonstrating that some Adirondack Mountains lakes had become acidic initiated a very public condemnation of smokestack emissions of both coal-burning power plants and smelters. The phenomenon was named "acid rain." Publication of the presence of acid-laden moisture in New England forests led to claims of impending forest destruction. Academics and environmentalists demanded shutdown of power plants and factories.

As a member of the National Advisory Committee on Oceans and Atmosphere (NACOA), a Ronald Reagan appointee, I was interested in the acid rain topic. The committee held a hearing about the topic that included testimony and presentations from both House and Senate environmental committee staffers.

The senate staffer, a lawyer, vociferously condemned industry for wanton destruction of forests and watersheds. I asked the question, "Have you considered the possibility of natural causes for acidification?"

His reply startled and infuriated me. "No competent scientist would even ask such a question."

That was my introduction to agenda-driven federal science. Unfortunately, it was also a portent for 21st century government science.

A former U.S. Geological Survey and EPA geologist testified in opposition to the consensus acid rain position, the only person who actually studied the Adirondack acidification in the field. He found that lake acidification was restricted mostly to the "prairie potholes" located in glacial drift, the sediments deposited in the last glaciation that were scraped from the Canadian Shield thousands of years earlier. These sediments contained abnormal amounts of mineral sulfides from ore deposits to the north. Normal weathering of the pyrite (iron sulfide) in these sediments created sulfuric acid, explaining the acidification.

The U.S. Department of Energy undertook a study of the causes and distribution of acid precipitation, but the results of that study were never released to the public. The draft report was featured on CBS's "60 Minutes," which made the case that there was no acid precipitation problem. I was able to obtain a copy of the draft report through my contacts at DOE. By that time the unfortunate principled geologist previously mentioned had been

See **Forum**, page 66

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PESA
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Forum
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terminated from his employment, and in a letter to the editor of Fortune magazine labeled a "charlatan" for not acceding to the scientific "consensus" about acid rain (I did not renew my subscription).

The National Acid Precipitation Assessment Program (NAPAP) draft report was data-laden. It completely falsified the acid precipitation theory but it was never released. Quietly, though, governmental concern over acid rain disappeared.

At present human effects on global climate is the consensus topic. The debate is dominated by computer modeling, an imperfect and already falsified approach to understanding the basic question of quantifying human effects. Even the theoretical basis is in question, since the original work that identified the greenhouse effect of carbon dioxide also placed limits on its ultimate effects.

The fundamental climate science problem today is to resolve the difference between data and models. Currently, models are given more weight than the actual measured data – a state of affairs incomprehensible to most "competent" scientists. Data do not support the consensus conclusions. The corporate/government management of the BBC recently decided that the BBC will not air any opinions skeptical of an anthropogenic or human basis for global climate change.

The BBC decision reflects a media bias against science and the scientific method. Lennart Bengtssen (University of Reading) was forced to resign from a skeptical think tank by his colleagues who refused to work with him further and because he "feared for his health and safety." He described his treatment as "McCarthy-style." Caleb Rossiter's termination from the Institute for Policy Studies after 23 years was for a simple op-ed in the Wall Street Journal questioning one of their positions.

Censorship of science is rampant, perhaps the worst since Galileo's inquisition. The net result is the loss of scientific credibility.

Science, once the epitome of objectivity, has gradually been reduced to theory-driven computer models that conflict with observations. The computer models are defended by ad hominem attacks, not objective testing. We do not know what causes climate to change over decades and centuries. What we do know, however, it that there are competing theories that demand testing.

Science suffers from the current unwillingness to test the two theories: natural climate change driven by solar system dynamics or climate change driven by human emissions of greenhouse gases. Sadly, the public increasingly dismisses science as irrelevant.

Lee Gerhard
Lawrence, Kan.

The Final Piece

I have read and re-read the commentary from Marlan Downey ("Thinking Like Oil," August EXPLORER) and in general I agree with his basic premise – to a point.

Mr. Downey makes several good points in understanding our need to know where source rocks are present, where these rocks have generated hydrocarbons and how these hydrocarbons then migrate into traps. Also he explains succinctly the concept of entry pore pressure and how oil must have sufficient buoyance pressure to enter into pores in reservoir rock.

What seems to be missing from Mr. Downey's discussion is the final piece of the oil puzzle – that is, defining the presence of reservoir rock of a minimum quality and quantity that can store oil or gas and then permit production at rates sufficient for economic development.

The definition or identification of these reservoir rocks does involve sequence stratigraphy, identification of environments of deposition and other studies that Mr. Downey might view as peripheral. There are countless examples around the world of oil emplaced in rock that is of such low quality (porosity and permeability) that the oil trapped shall forever be in-place.

After all, finding oil or gas in place is not the key – producing oil into the tank or gas into the pipeline with positive economic returns are the prize we all seek.

Finally, operators have produced oil from the Bakken for many years, starting in the 1970s. The first production was from vertical wells that did happen to encounter a fracture or two. Production rates were typically in the range of 35-50 BOPD (barrels of oil per day) with little or no water and very low decline rates.

The ability to drill a horizontal well for a mile and keep the bit in a 15-foot thick zone did not exist in the 1970s. It took a leap in technology in horizontal drilling or geosteering and LWD logging to permit the Bakken play to flourish as it has today.

Pete Chimney
Houston

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POSITION AVAILABLE

Stephen F. Austin State University:
Chair, Department of Geology

The Department of Geology at Stephen F. Austin State University invites applications for the department chair position. We seek an individual with strong management, communication, and interpersonal skills to provide innovative and energetic leadership. Duties include managing curricula, budgets, student enrollment, personnel, program assessment, and developing strong, mutually beneficial relationships with industry and alumni. The incumbent will teach a reduced load of courses and develop a research program in his/her area of expertise. Applicants must have credentials for appointment at the associate or professor rank in geology.

Submit a letter of application, CV, and contact information for three references to https://careers.sfasu.edu (posting 0603046).

Also mail official transcripts to:

- Dr. Kenneth Farrish, Search Committee Chair
- Stephen F. Austin State University Department of Geology
- PO Box 13011 SFA Station Nacogdoches, TX 75962-3011
- (936) 468-3701

Review of applications will begin on Jan. 9 and will continue until the position is filled. Equal Opportunity Employer; Security-sensitive position; this position will be subject to a criminal history check.

See more at: http://www.aapg.org/career/jobs/classifieds/ad/articleid/10656/stephen-f-austin-state-university-chair-department-of-geology#sthash.A35MrGe8.dpuf

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The Department of Geology at Colgate University invites applications for a tenure-stream position in Geophysics (area of specialization open) at the rank of Assistant Professor, beginning fall semester 2015. We seek an individual committed to excellence in teaching and research at the undergraduate level. Completion of the Ph.D. is expected prior to or shortly after the date of hire. The successful applicant will teach Geophysics and other courses at the introductory level for non-majors and the upper-level for geology students, as well as contribute to all-university curricula. A cover letter, CV, research and teaching statements, and reference letters must be submitted through https://academicjobsonline.org/ajo/jobs/4548, where full details of the position are posted. Candidates are encouraged to describe their strengths and experiences in teaching diverse student populations and in promoting a diverse and inclusive educational environment. Colgate is an EEO/AA employer; women and candidates from historically underrepresented groups are especially encouraged to apply. Review of applications will begin October 13, 2014, and will continue until the position is filled.

Society of Exploration Geophysicists
Executive Director

SEG
Society of Exploration Geophysicists
The international society of applied geophysics

The Society of Exploration Geophysicists seeks an executive director to lead a staff of approximately 100 and manage an annual budget of approximately $25M. SEG is a 32,000-member association headquartered in Tulsa, OK, with regional offices in Beijing and Dubai. The organization includes a foundation and three subsidiaries, and the executive director has responsibilities associated with each of those components. The successful candidate will have sufficient experience to manage an organization of SEG's size and complexity, be able to travel globally and conduct international business, and work effectively across cultures in a volunteer-led organization.

The position requires a familiarity with finance and complex corporate structures, specifically subsidiaries and affiliates, and related accounting and governance requirements.

Essential duties and responsibilities include the following. Other duties may be assigned. The executive director:

1. Maintains effective staff organization, morale, and performance to assure service to members.
2. Oversees the adequacy and soundness of the organization's financial structure.
3. Reviews operating results of the organization, compares them to established objectives, and ensures appropriate measures are taken to optimize results.
4. Establishes and maintains an effective system of communication throughout the organization.
5. Contributes to development of current and long-range objectives, plans, and policies, subject to board-of-directors approval.
6. Represents the organization with members, the petroleum industry, and the general public.
7. Travels extensively, domestically and internationally, to SEG events, conferences, and exhibitions.

The executive director reports directly to the SEG president and a board of directors installed through annual elections. The position is in Tulsa, OK, at the SEG Business Office.

Qualifications:

1. BS in a technical field and 8-10 years relevant experience, MS or MBA a plus.
2. Strong financial and budgeting skills.
3. Ability to read, analyze, and interpret common scientific and technical journals, financial reports, and legal documents.
4. Ability to respond to common inquiries or complaints from SEG members, regulatory agencies, news organizations, or members of the business community.
5. Ability to effectively present information to top management, public groups, and/or boards of directors.
6. Excellent diplomacy and communication skills (verbal and written).

Please e-mail a letter detailing interest, qualifications, and salary requirements and a résumé with references to execsearch@seg.org. Applications received by 1 November 2014 will receive full consideration; the position will remain open until filled. SEG is an equal opportunity employer.

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DIRECTOR
OKLAHOMA GEOLOGICAL SURVEY
UNIVERSITY OF OKLAHOMA

The Oklahoma Geological Survey (OGS) seeks applications for an exceptional, dynamic and visionary leader to serve as the 8th Director in its 106-year history. Located on the University of Oklahoma campus in Norman, Oklahoma, the OGS is a key public research and service organization, and the only state geological survey in the nation chartered in a state constitution. The OGS mission focuses on investigating and disseminating information regarding land, water, mineral and energy resources, and promoting sound environmental practices.

Organizationally, the OGS is located within the Mewbourne College of Earth and Energy, and the OGS Director reports to the College Dean. Also located in the College are the ConocoPhillips School of Geology and Geophysics, and the Mewbourne School of Petroleum and Geological Engineering. The ConocoPhillips School of Geology and Geophysics, founded by Charles Gould in 1900, is home to the first school of Petroleum Geology, with the first degree granted in 1904. Charles Gould subsequently became the first Director of the OGS. The Mewbourne School of Petroleum and Geological Engineering is home to the first school of Petroleum Engineering, with the first petroleum engineering degree being granted in 1927.

Candidates should hold a doctorate or have the equivalent experience in geology, geophysics or a closely related field. Prior experience with a public agency, such as the OGS, would be beneficial. If appropriate, the successful candidate may hold a dual appointment as a faculty member within the College. Salary will be commensurate with qualifications and experience.

The Director of the OGS has the responsibility of overseeing activities related to geological and geophysical studies of Oklahoma and adjacent areas, preparation of reports documenting the findings of these studies, communication of these results to individuals and agencies, and engaging the general public as appropriate and/or required.

The position requires supervision and administration of an organization of approximately 40 staff and associated facilities including offices, labs and the Oklahoma Petroleum Information Center (OPIC), which contains an extensive collection of rock cores and samples, other well information and selected facilities for the examination of these cores and samples. It is anticipated that the Director of the OGS will work with Oklahoma universities, state and federal agencies, industry and other entities to conduct research in areas of public interest, as well as provide advice and service in the areas of geology, geophysics and natural resources. The ability to assist OGS personnel in developing programs and proposals to acquire research funding in support of OGS activities will also be a consideration.

The OGS is one of five State Surveys at the University of Oklahoma; the others are the Oklahoma Climatological Survey, Oklahoma Water Survey, Oklahoma Archeological Survey and Oklahoma Biological Survey. Specific activities of the OGS include the following:

(a) A study of the geological formations of the state with special reference to its natural resources, including coal, oil, gas, asphalt, gypsum, salt, cement, stone, clay, lead, zinc, iron, sand, road building material, water resources and all other mineral resources.

(b) Management of the Oklahoma seismic recording network, and the reporting and analysis of earthquake activity in the state; an area of current high interest given the recent, significant increase in Oklahoma earthquake activity.

(c) The preparation and publication of bulletins and reports, accompanied with necessary illustrations and maps, including both general and detailed descriptions of the geological structure and mineral resources of the state.

(d) The consideration of such other related scientific and economic questions that shall be deemed of value to the people of Oklahoma.

The successful candidate will have the demonstrated experience and ability to oversee these activities, while embracing the public service mission of the OGS and acting as the State Geologist of Oklahoma. Areas of experience that could be considered include an appropriate background with state or national surveys, administration in academia, experience in industry or research, or other related areas.

Review of candidates will begin October 15th, 2014 and continue until the position is filled. The

Continued on next page

Continued from previous page

anticipated starting date is as soon as practical in early 2015. Applicants are requested to submit a complete resume, statement of relevant experience and a list of five references who can be contacted, including names, phone numbers, e-mail addresses and complete mailing addresses. Questions or requests for additional information may be addressed to Larry R. Grillot, Dean of the Mewbourne College of Earth & Energy, and Chair of the OGS Director Search Committee, at (405) 325-3821, or lrgrillot@ou.edu. Applications and nominations should be addressed to OGS Director Search Committee, University of Oklahoma, Sarkeys Energy Center, 100 East Boyd Street, Room 1510, Norman, OK 73019-1008.

The University of Oklahoma is an Affirmative Action, Equal Opportunity Employer. Women, minorities, protected veterans and individuals with disabilities are encouraged to apply.

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UNIVERSITY OF KENTUCKY
Kentucky Geological Survey

Director
Kentucky Geological Survey
University of Kentucky

The University of Kentucky seeks a Ph.D.-level geoscientist to serve as the Director of the Kentucky Geological Survey in Lexington, Kentucky and the 13th State Geologist of Kentucky. This is a high-level administrative position within the university. For more information about the duties of this position go to kgs.uky.edu/StateGeologist. To apply for job # RE00309, submit a UK Online Application at www.uky.edu/ukjobs. If you have any questions, contact HR/Employment, phone (859) 257-9555 press 2. Application deadline is November 16, 2014.

The University of Kentucky is an equal opportunity employer and encourages applications from minorities and women.

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ASSISTANT PROFESSOR OF EARTH AND ATMOSPHERIC SCIENCES

(Exploration Geophysics)

Applications are invited for a tenure track position as Assistant Professor in the Department of Earth and Atmospheric Sciences at the University of Nebraska-Lincoln. The successful candidate will be expected to participate in teaching and curricular development of undergraduate and graduate courses, to advise and direct graduate students, and to develop a rigorous research program that is supported by external funding. It is expected that the research program will include field and subsurface-based studies of exploration geophysics. Ability to contribute to growing petroleum geoscience-related teaching and research activities within the Department of Earth & Atmospheric Sciences will be considered as an advantage. The candidate should demonstrate strong potential for research and teaching and must hold a Ph.D. in Geology or a related field at the time of appointment. Female and ethnic minority candidates are strongly encouraged to apply.

The Sedimentary Geology and Paleontology, Meteorology/Climatology, and Hydrosphere Geosciences programs serve as the three primary units within the Department of Earth & Atmospheric Sciences. The department offers B.S. degrees in Geology and Meteorology/Climatology, as well as M.S. and Ph.D. degrees in Earth and Atmospheric Sciences. Additional information about our department can be found on our Web site: http://eas.unl.edu.

To apply, go to http://employment.unl.edu requisition 41016 and complete the "faculty/administrative form." Applicants must attach a cover letter, curriculum vitae, a statement detailing research and teaching interests, and names of at least three references via the above website. We will begin to review applications on November 5, 2014, but the position will remain open until it is filled.

The University of Nebraska is committed to a pluralistic campus community through affirmative action, equal opportunity, work-life balance, and dual careers. For further information, contact Dr. Chris Fielding, Search Committee Chair by email, phone, or mail at: cfielding2@unl.edu, 1-402-472-9801; Department of Earth & Atmospheric Sciences, University of Nebraska-Lincoln, 214 Bessey Hall, Lincoln NE 68588-0340.

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Richard T. Buffler Post-Doctoral Fellowship

A post-doctoral fellowship is being established within the Institute for Geophysics (UTIG), Jackson School of Geosciences (JSG), The University of Texas at Austin for the purpose of honoring Dr. Richard (Dick) T. Buffler, whose scientific research into the geology of the Gulf of Mexico (GOM) underpins our current rich understanding of this prolific hydrocarbon basin and the unique confluence of structural and stratigraphic processes related to its formation and fill.

Dick worked at UTIG from 1975 until his retirement in 2002, collecting and interpreting new seismic data from the Gulf basin. He participated in 12 Gulf of Mexico cruises (including co-chief scientist of DSDP Leg 77), and he authored or coauthored over 83 publications related to the Gulf. He also mentored 73 students many of whom produced Masters or PhD theses related to the Gulf (33), and he helped lead a major UTIG research effort in the GOM, the Gulf Basin Depositional Synthesis (GBDS) project, which has enjoyed 19 years of continuous industry support under Dr. William E. Galloway and now its current director, Dr. John W. Snedden.

The successful applicant for this new position should have the following skills:

1. Demonstrated research interest in basin-scale depositional systems, ranging from alluvial to deep-water, siliciclastics and carbonates, Pleistocene to base Mesozoic.
2. Competence in seismic interpretation, including experience with 2D or 3D seismic workstation software.
3. Competence in geological interpretation of well logs.
4. Knowledge of biostratigraphy and use of fossil datum for correlation.
5. Excellent oral presentation and writing skills.
6. Experience with ArcGIS and other computer software (Word, Excel, PowerPoint, etc.).

Essential Job Functions:

1. Identify and lead new research avenues in Gulf of Mexico depositional systems that support existing and future exploration efforts of the GBDS Industrial Associates.
2. Generate scientific publications that enhance the technical reputation of UTIG, The Jackson School of Geosciences, (JSG) and The University of Texas at Austin.
3. Conduct and present research to industrial associates with clarity and a deep understanding of their oil and gas industry challenges.
4. Collaborate with UTIG and JSG researchers and faculty, where appropriate.
5. Mentor undergraduate and graduate students as appropriate.
6. Domestic travel as needed.

The position will have two years of initial support and will be based in Austin, Texas. Interested Persons should submit a detailed Curriculum Vitae (CV) that includes academic and professional experience, statement of research interests and names and contact information of three references to PostDocUTIG@ig.utexas.edu. For full consideration, applications must be received by October 15, 2014

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DIRECTOR'S CORNER

Student Expos and the Big Picture

By DAVID CURTISS

As this issue of EXPLORER goes to print, geoscience students and industry recruiters are gathering on the plains of Wyoming for the Rocky Mountain Rendezvous, the annual job fair of AAPG's Rocky Mountain Section.

It's a sold-out event. And under the watchful gaze of AAPG president Randi Martinsen, a faculty member at the University of Wyoming where the event takes place, students from across the country will be meeting and interviewing with oil and gas companies who are looking to identify and recruit new talent to their firms.

(For more insight into the origins of this event, don't miss our story on page 34 of this month's EXPLORER.)

The Rocky Mountain Rendezvous follows on the heels of the very successful AAPG/SEG Student Expo in Houston, held in early September with approximately 750 students registered.

Now in its 17th year, the Houston Expo is a testament to the sustained dedication of volunteers to invest in the next generation geoscience workforce. The efforts of a very active committee are led by co-chairs Cecilia Ramirez of American Energy Partners, LP and Fernando Enrique Ziegler of Marathon Oil.

AAPG Honorary member Martha Lou Broussard of Rice University has been involved since the very first event in Houston and was awarded the AAPG Presidential Service Award by past president Lee Krystinik and the Executive Committee this past year for her commitment to and leadership of the AAPG/SEG Student Expo.

She has been encouraging me to attend the event since I began this job. And this year I was finally able to be there.

AAPG Executive Director David Curtiss, Student Expo Committee Vice Chair Fernando Ziegler, Student Expo Committee Chair Cecilia Ramirez, SEG past President Bill Barkhouse.

* * *

What an experience.

Picture this: Hundreds of students from across the United States and the world who are enthusiastic about working for the oil and gas industry and eager to successfully launch their careers, packed into one place.

The room crackled with energy as these hundreds of students, dressed in their best business attire, lined up to talk to recruiters.

There was both excitement and trepidation in their eyes. This was their chance to make a good first impression. This was a big deal for their future careers and for the future of our industry.

Students also had the opportunity to give poster presentations about their research – and as I explored the posters and talked to the students I was impressed by the scientific and technical complexity of their projects. By and large, the current generation of students is doing sophisticated science.

But the question I probed was whether they understood why.

When I talk to students about their careers, one of the skills I urge them to develop is an understanding of the big picture and an understanding of how their particular scientific discipline fits into that picture.

"All geology is interesting; some geologic work is novel; damn little of the work we see is useful in finding new oil and gas fields," is how past AAPG president and Sidney Powers medalist Marlan Downey put it in his provocative commentary in the August EXPLORER.

In our industry, science isn't the end; it's a means to an end.

And I was heartened to see that several of the students whose posters I judged at the expo understood the need to integrate across disciplines and could communicate the broader implications of their work. They shared with me how their research applied in an exploration context.

That's good news for our industry where creativity and cooperation across disciplines, both scientific and business, is essential to delivering the energy resources the world needs.

* * *

You still have two opportunities in 2014 to attend an AAPG student expo:

- Oct. 2-4 – the AAPG-SEG West Coast Student Expo in Northridge, Calif.
- Nov. 2-3 – the AAPG Eastern Section Student Expo in Morgantown, W.Va.

Thanks to the companies that sponsor and recruit at the student expos. Thanks to the volunteers who organize and make these expos successful.

And thanks to the students for your interest in serving humanity through your profession.

DIVISIONS REPORT: DPA

Top 10 Reasons to Join DPA

By RICK FRITZ, DPA President

The Unconventional Resource Technology Conference, or URTeC (pronounced "Your Tech") just completed its second annual meeting in August with about 5,000 attendees.

The primary purpose of the conference is to bring multi-disciplinary resource play technology to the industry and public. The secondary purpose is to develop a unique program of cooperation among SPE, AAPG and SEG.

Many AAPG DPA members played key leadership roles in the development of URTeC. This new conference has been a success in both purposes and is a now a showcase for professional cooperation, especially in relationship with resource plays.

Developing a clear purpose is critical with any program.

As AAPG Division of Professional Affairs president I am often asked, "What is the DPA's purpose?" I decided one of the best ways to answer this question is take the Letterman approach with a Top 10 list of purposes and reasons to be part of DPA.

FRITZ

Developing a clear purpose is critical with any program.

Top 10 reasons to be a member of DPA:

10. **Professional resources** – DPA is the largest division with AAPG and has many resources at its disposal, including the human resources provided by Norma Briggs, divisions manager. Norma can help with any information on professional development and governmental affairs.

9. **Governmental affairs** – The AAPG GEO-DC office was developed and strongly supported by DPA members. It has been successful in developing relationships with congressmen and education for congressional professional staffs. GEO-DC also keeps AAPG members informed on government affairs and trends that can impact our business including international applications.

8. **Access to professional publications, newsletters and website**. The purpose of the DPA Correlator is to provide current information and issues on professional activities for all DPA members. In addition, the DPA has published a few key publications in particular, like the popular "Heritage of the Petroleum Geologist," which is regularly provided to students and young professionals.

7. **Continuing education** – DPA offers professional development hours (PDHs) through short courses usually held at the AAPG annual convention or at Section/Region meetings. Examples of DPA short courses are "Black Belt Ethics" and "Geosteering."

6. **Conferences** – DPA is providing new opportunities for professional development in the form of the Playmaker forums. The primary purpose of Playmaker is to bring leaders from industry to present their ideas, successes and even failures in developing new plays. A secondary purpose of Playmaker is to provide training for professionals in prospect generation and presentations.

5. **Career development** – A key purpose of DPA is to provide mentors to help guide professionals in their careers. Support is provided by a community of top professionals with knowledge and opportunities for development. This is a great area for young professionals to plug into DPA.

4. **Networking** – One of the most important aspects of DPA is the opportunity to make and build business contacts. Many DPA members are active explorers and we have a heritage of success in business.

3. **Ethics** – Professional values are an important aspect of DPA certification and it is important for DPA to promote a "gold standard" for ethics within our industry. DPA offers short courses and online training for ethics.

2. **Certification** – The original purpose of DPA was certification for petroleum professionals. Unlike government certification DPA provides *peer* certification. This is an important distinction. Whereas government certification is primarily for control and taxation of professionals, DPA exists to support and promote its members.

1. **Leadership!** All of the above is about leadership. Since DPA was formed many of AAPG's past presidents were DPA members. Many of the leadership positions in AAPG are held by DPA members.

Jack Welsh, past chairman of GE, once said, "Before you are a leader, success is all about growing yourself. When you become a leader, success is all about growing others."

This is a great motto and summarizes the purpose of DPA. We appreciate all DPA members and I encourage you to take the opportunity to enjoy the benefits of DPA membership.

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